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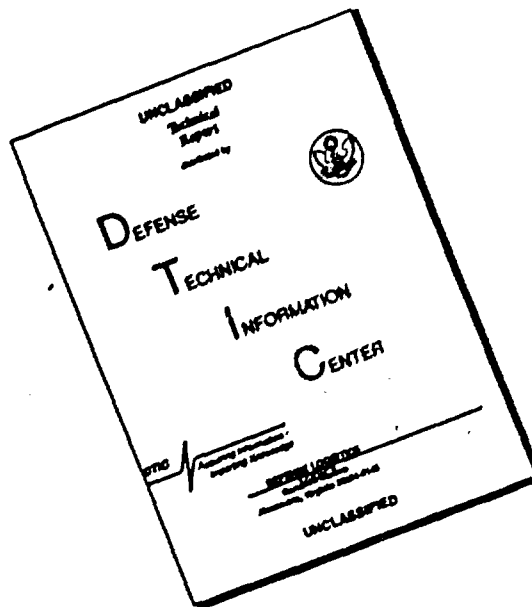
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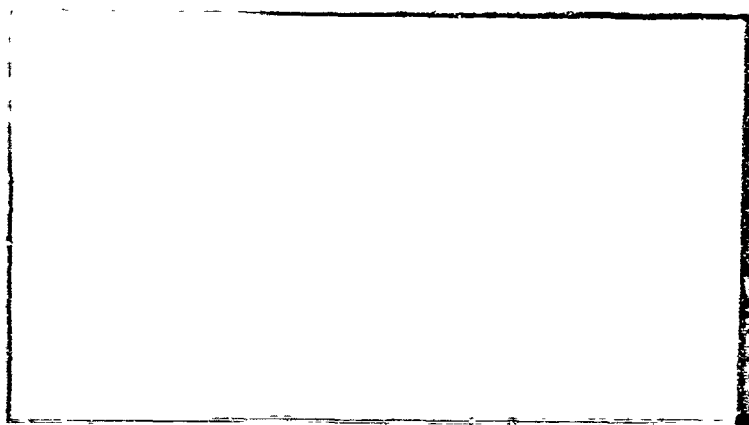
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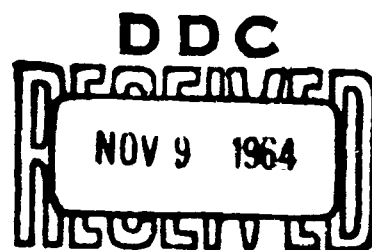
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NEDERLANDSCH SCHEEPSBOUWKUNDIG PROEFSTATION
NETHERLANDS SHIP MODEL BASIN

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✓ Contract No.N 62558-3463

Modification No.1

Experimental and theoretical
research on the hydrodynamic
characteristics of large hub
to diameter ratio propellers.

✓ Final Report - Supplement No.3

NEDERLANDSCH SCHEEPSBOUWKUNDIG PROEPSTATION	WAGENINGEN	NO.	BLZ.
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Final Technical Report.

Supplement 3.

Experimental and theoretical research on the
hydrodynamic characteristics of large hub to
diameter ratio propellers.

Contract No. N 62558 - 3463.

Supplement 3.

The hydrodynamic characteristics of the aft propeller without shroud of the tandem propeller submarine.

This supplement contains the reduced data of the experiments which are carried out in order to yield data with respect to the hydrodynamic properties of the aft propeller without shroud of the T.P.S. under static conditions. The forward propeller was fixed with the blades in feathering position.

The dimensionless forces and moments on the model with the operating aft propeller, corrected for the forces and moments on the body without propeller blades and shroud are defined by:

$$K_x ; K_y ; K_z ; Q_x ; Q_y ; Q_z .$$

The dimensionless torque on the aft propeller is defined by:

$$Q_2$$

The efficiency of the propulsion device is defined by:

$$\eta_1 = \frac{\Lambda}{2\pi} \cdot \frac{K_x}{Q_2}$$

The parameter Λ is the advance ratio in this case based on the number of revolutions per second of the aft propeller. The geometry of the model is summarized in figure 1.

The total pitch angle β for each blade of the aft propeller can be varied according to the following program:

$$\beta = \beta_0 + \beta_1 \sin \varphi + \beta_2 \cos \varphi$$

NEDERLANDSCH SCHEEPSBOUWKUNDIG PROEFTATION WAGENINGEN	NO.	BLZ. 2.
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The pitch angle for positive β_1 and β_2 equal to zero is therefore maximum in the top position of the blade and minimum in the bottom position. The pitch angle for β_1 equal to zero and positive β_2 is maximum with the blade to starboard and minimum with the blade to port.

The results of the experiments are analysed and given in the following diagrams:

figure 2,1,1 - K_x and Q_2 are plotted as a function of Λ with β_0 as parameter.

figure 2,2,1 - Q_x and η are plotted as a function of Λ with β_0 as parameter.

figure 2,3,1 - 2,3,3

K_x and Q_2 are plotted as a function of Λ with β_1 or β_2 as parameter for some values of β_0 .

figure 2,4,1 Q_x is plotted as a function of Λ with β_1 or β_2 as parameter for some values of β_0 .

figure 2,5,1 K_x and Q_2 are plotted as a function of Λ with β_0 as parameters for some values of ψ .

figure 2,6,1 - 2,6,4

K_y and K_z are plotted as a function of Λ with β_1 and β_2 as parameters for some values of β_0 .

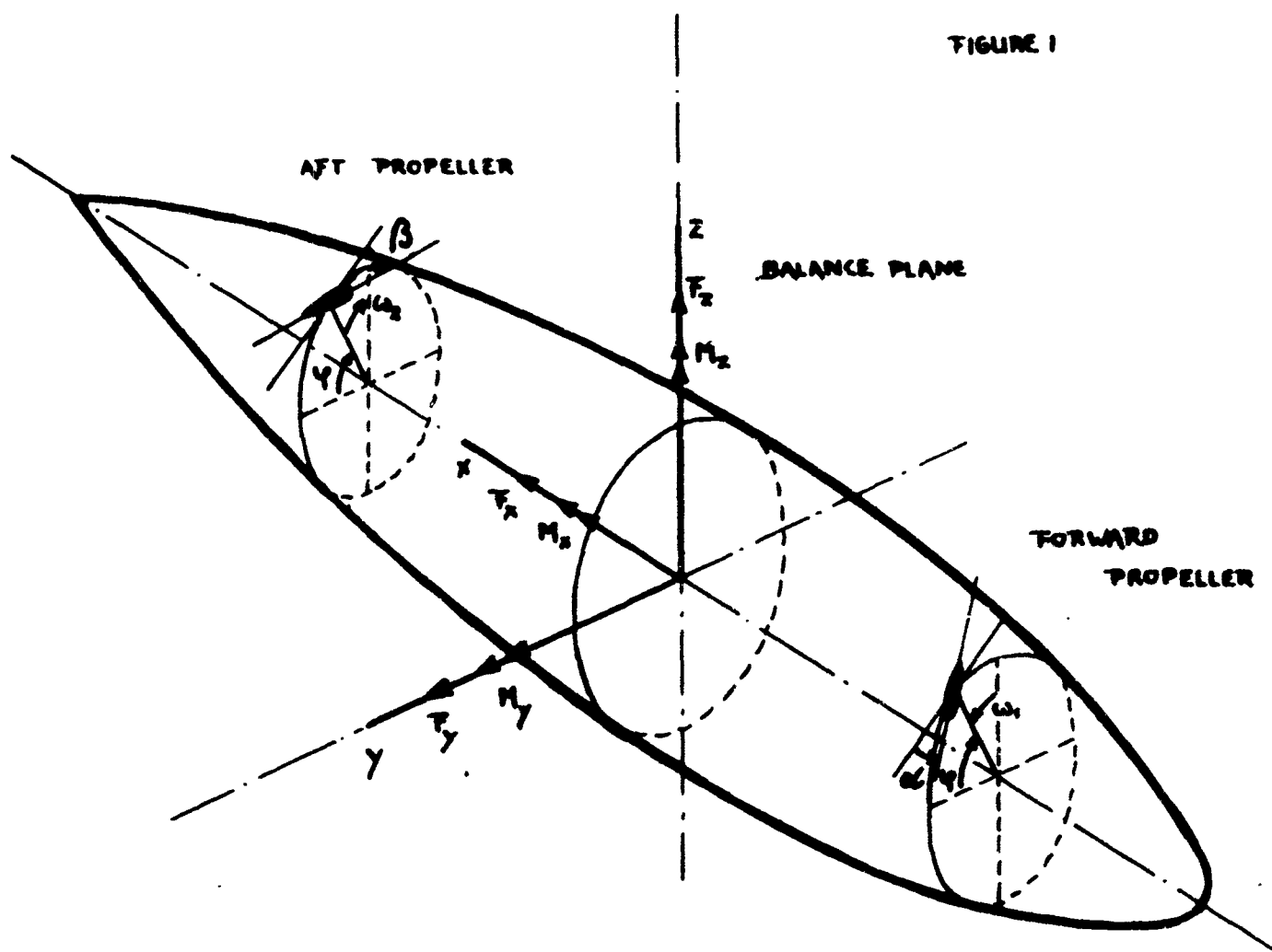
figure 2,7,1 - 2,7,4

Q_y and Q_z are plotted as a function of Λ with β_1 and β_2 as parameters for some values of β_0 .

figure 2,8,1 - 2,8,4

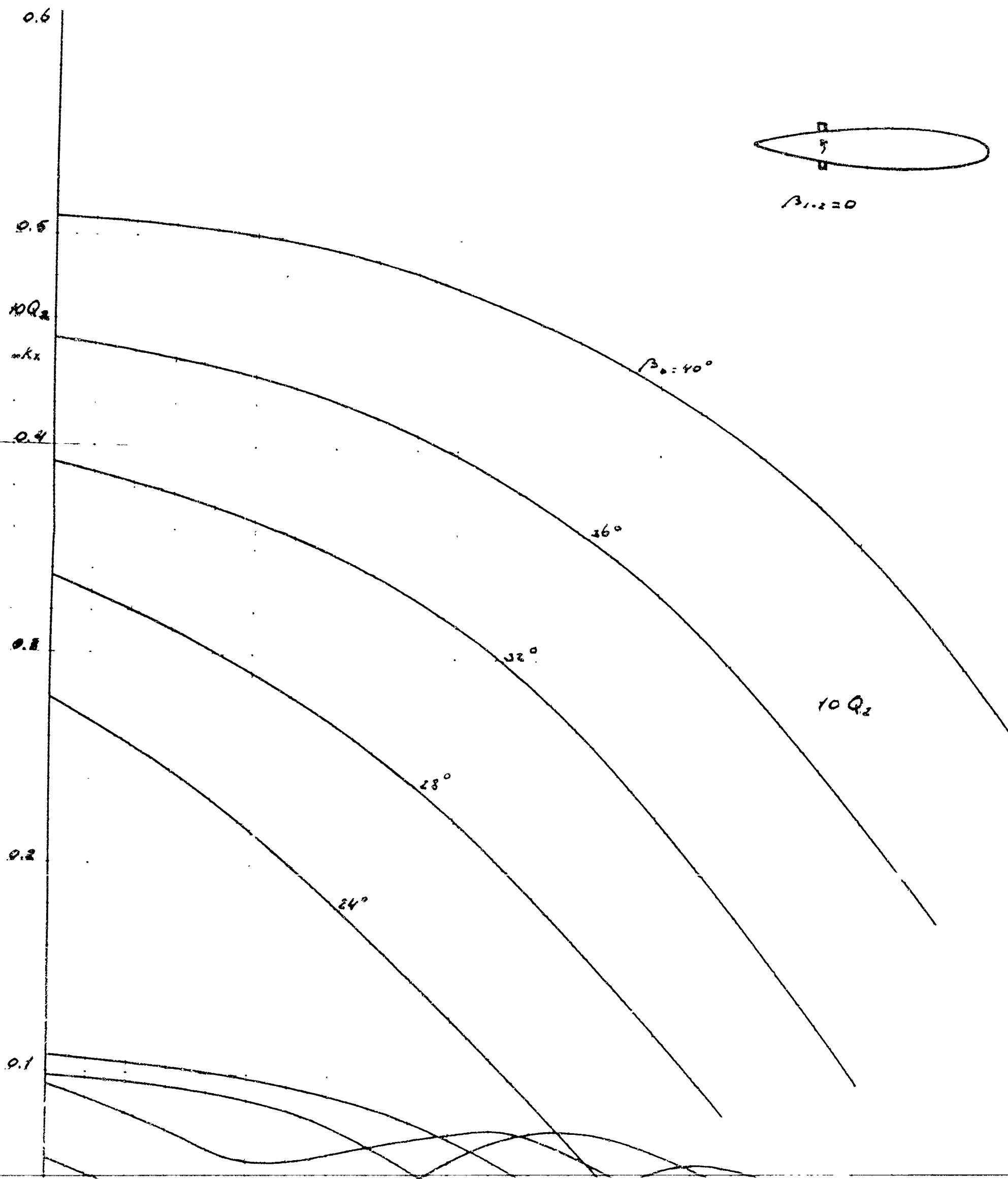
The resulting transverse forces and moments are plotted as a function of Λ and β , for some values of β_0 . The forces and moments are thus given in vector form.

FIGURE 1



$$\alpha = \alpha_0 + \alpha_1 \sin \varphi + \alpha_2 \cos \varphi$$

$$\beta = \beta_0 + \beta_1 \sin \varphi + \beta_2 \cos \varphi$$



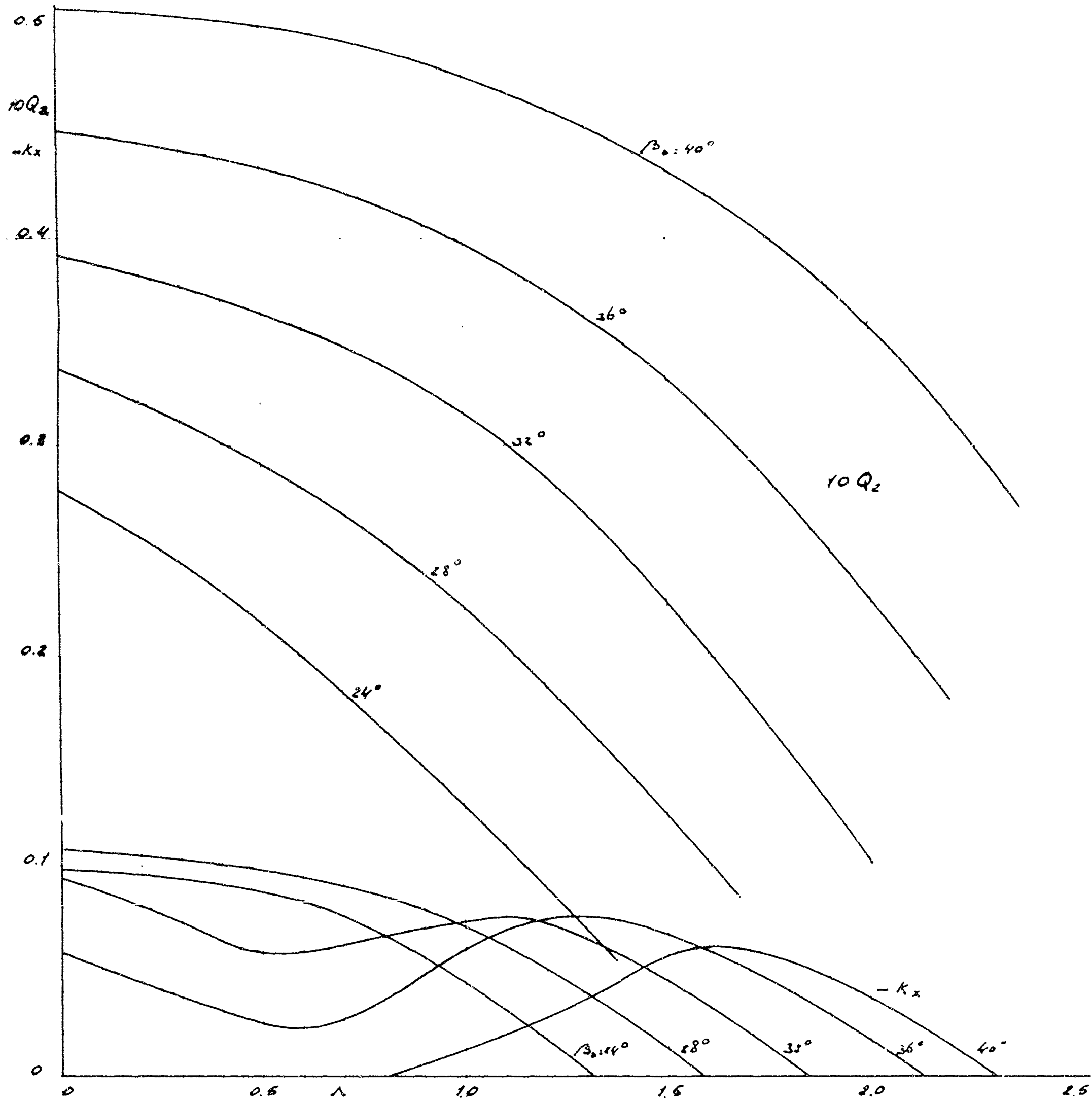


fig 2.1 1

0.06
0.05
0.04
-Q_x
0.03
0.02
0.01

$\beta_0 = 40^\circ$

36°

32°

28°

$\beta_0 = 24^\circ$

28°

32°

36°

40°

-Q_x



$\beta_{1-2} = 0$

7

0.6
0.5
0.4
0.3
0.2

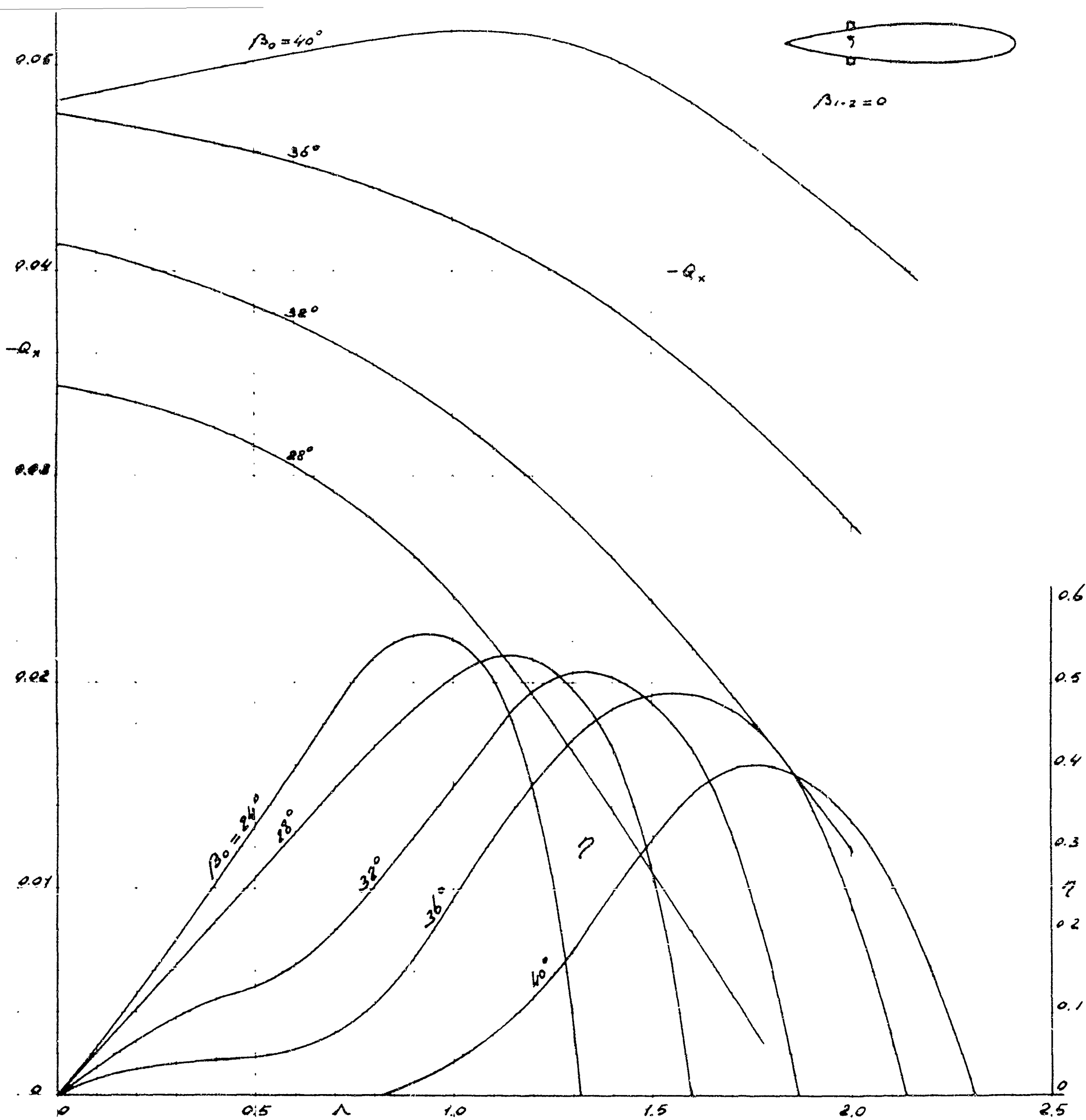
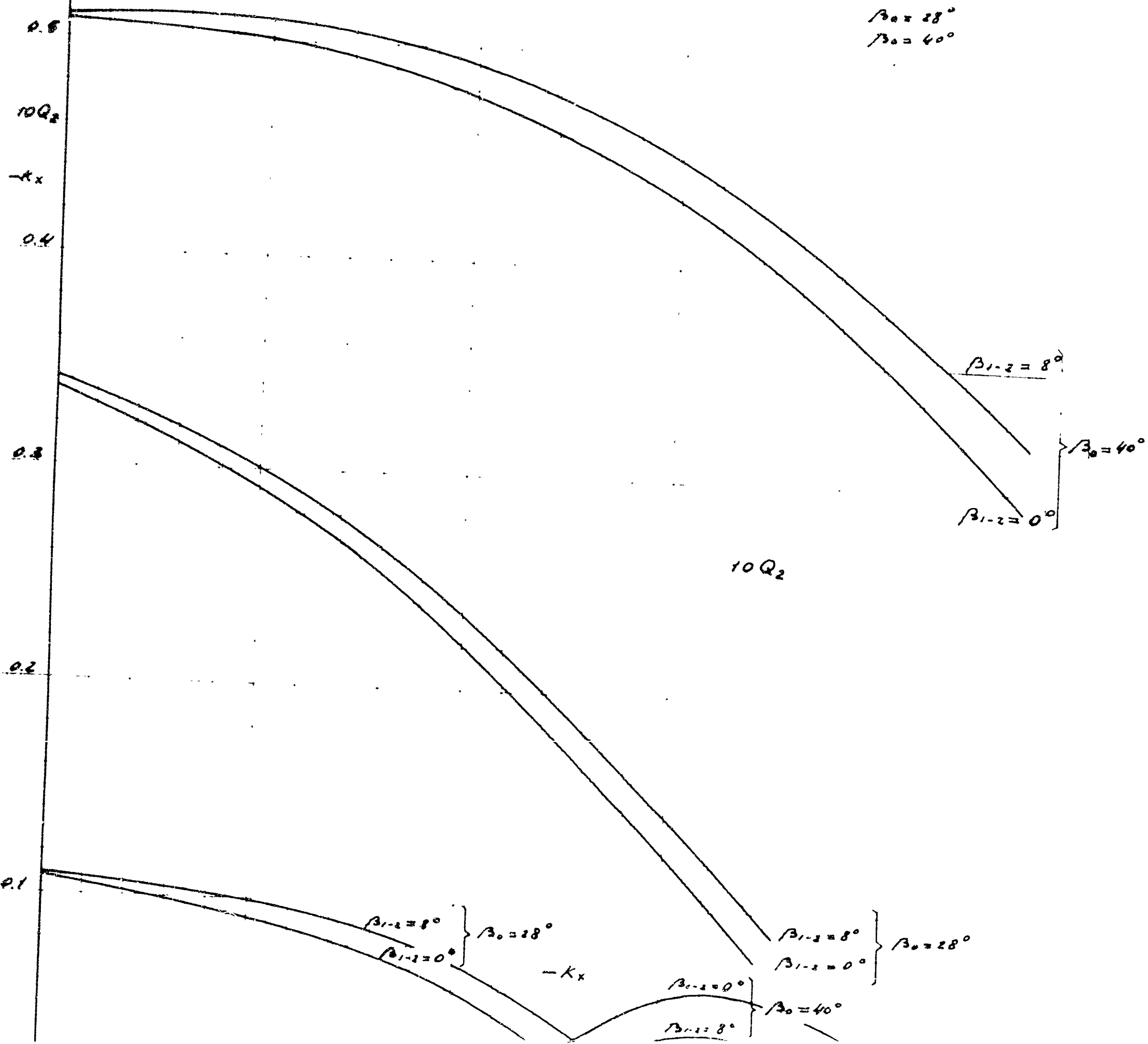


fig. 2.2.1



$$\beta_0 = 28^\circ$$

$$\beta_0 = 40^\circ$$



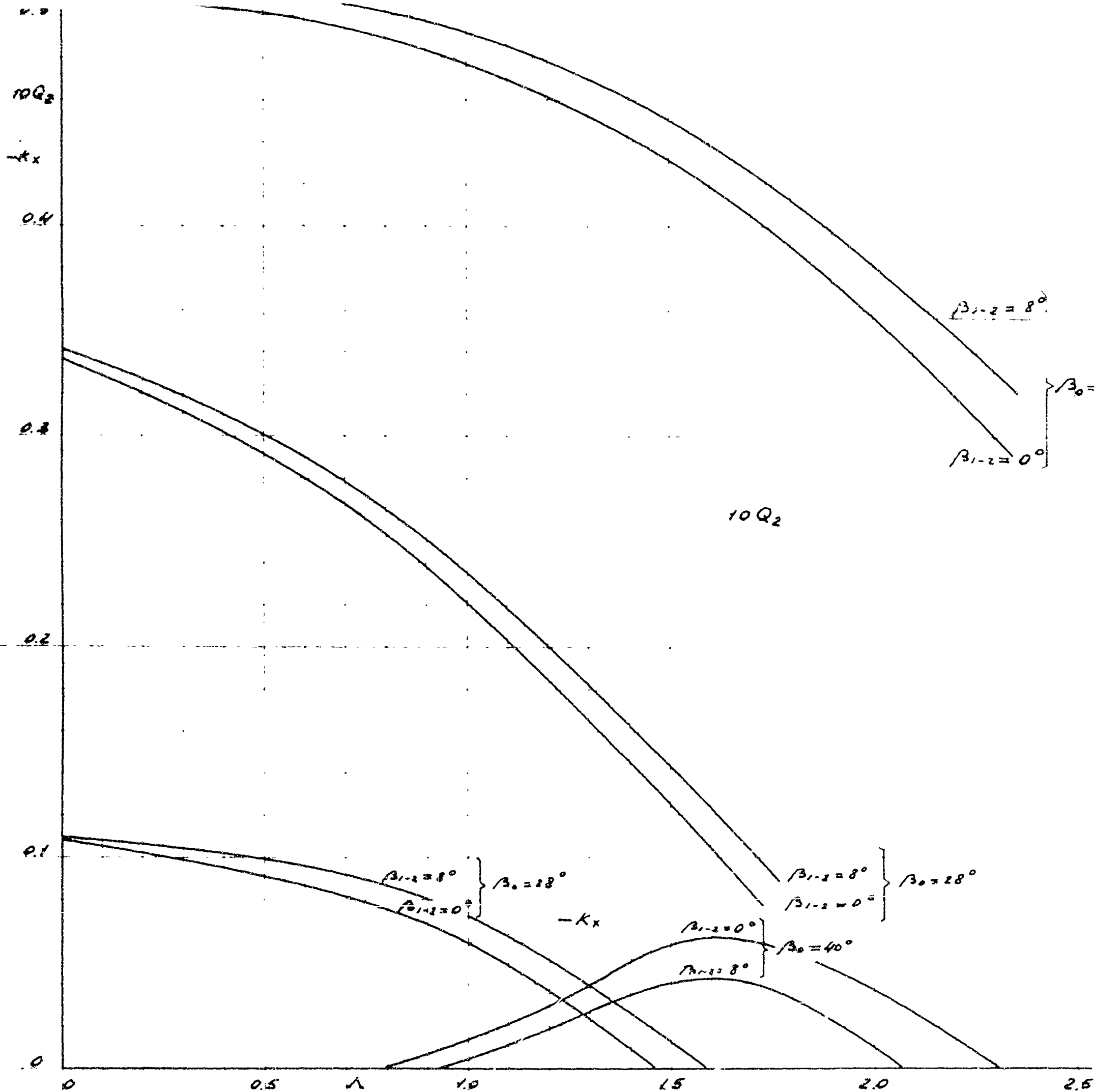


fig.2 3 1

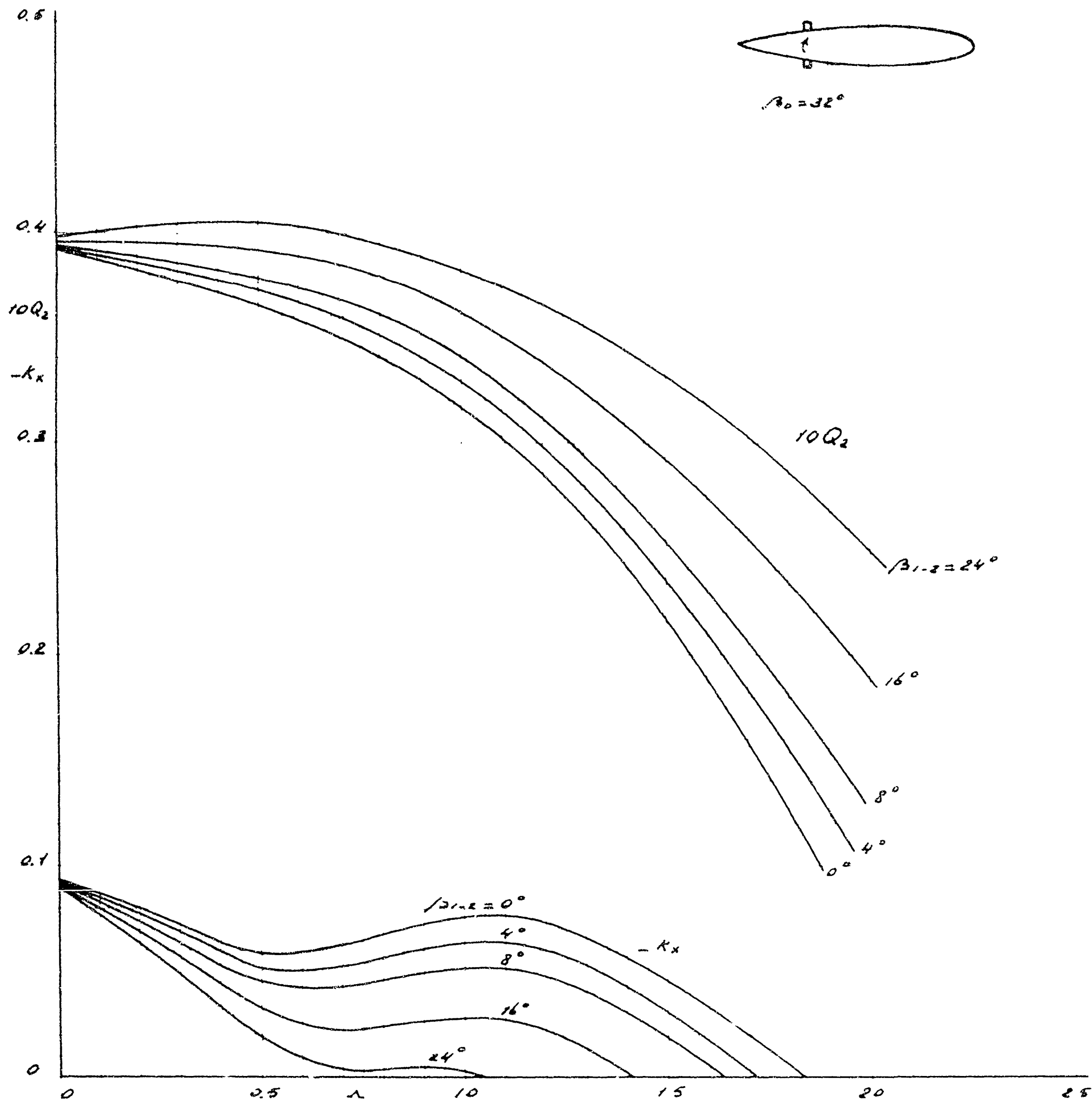
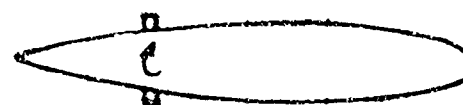
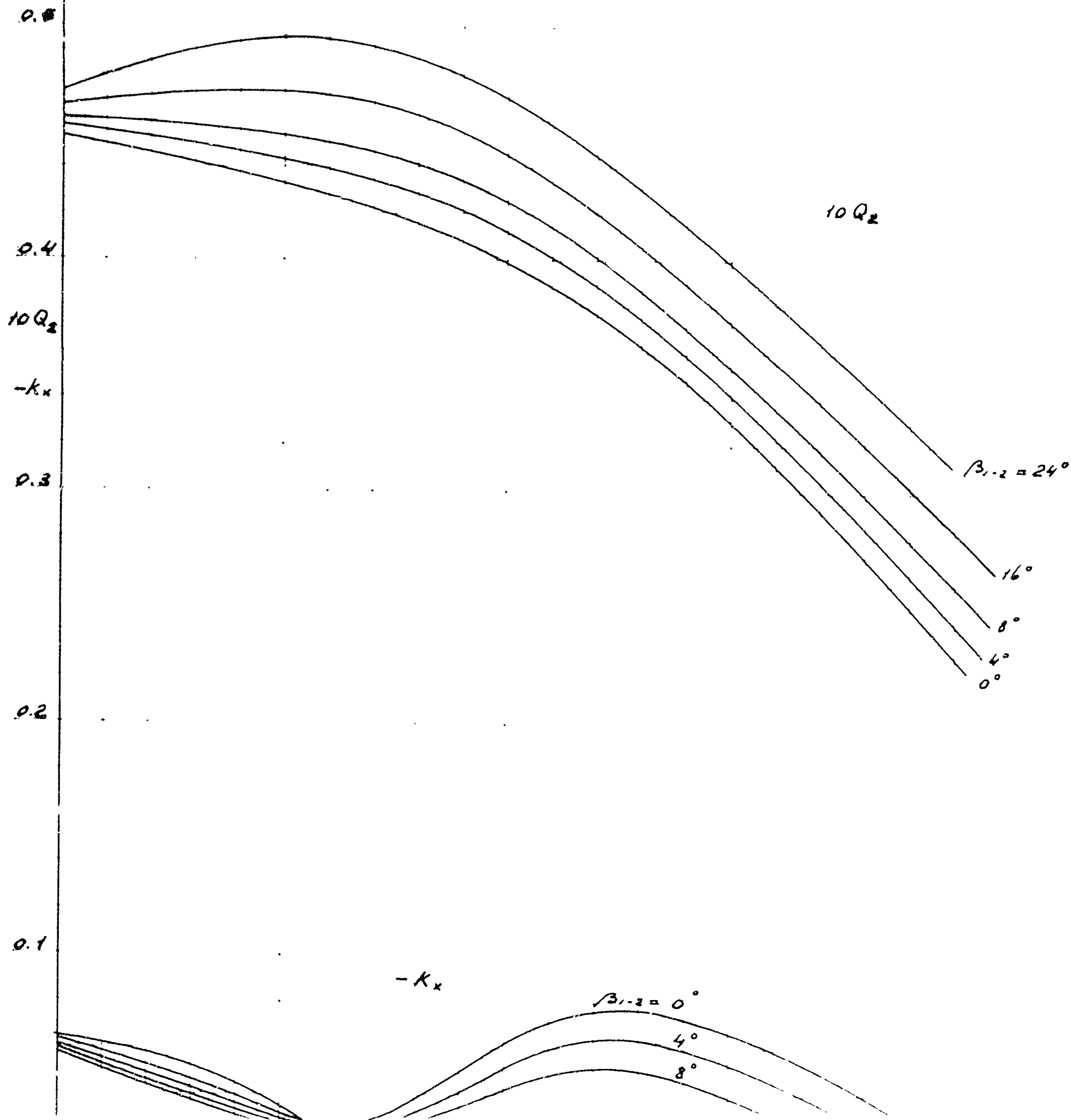


fig. 2.3 2



$$\beta_0 = 36^\circ$$



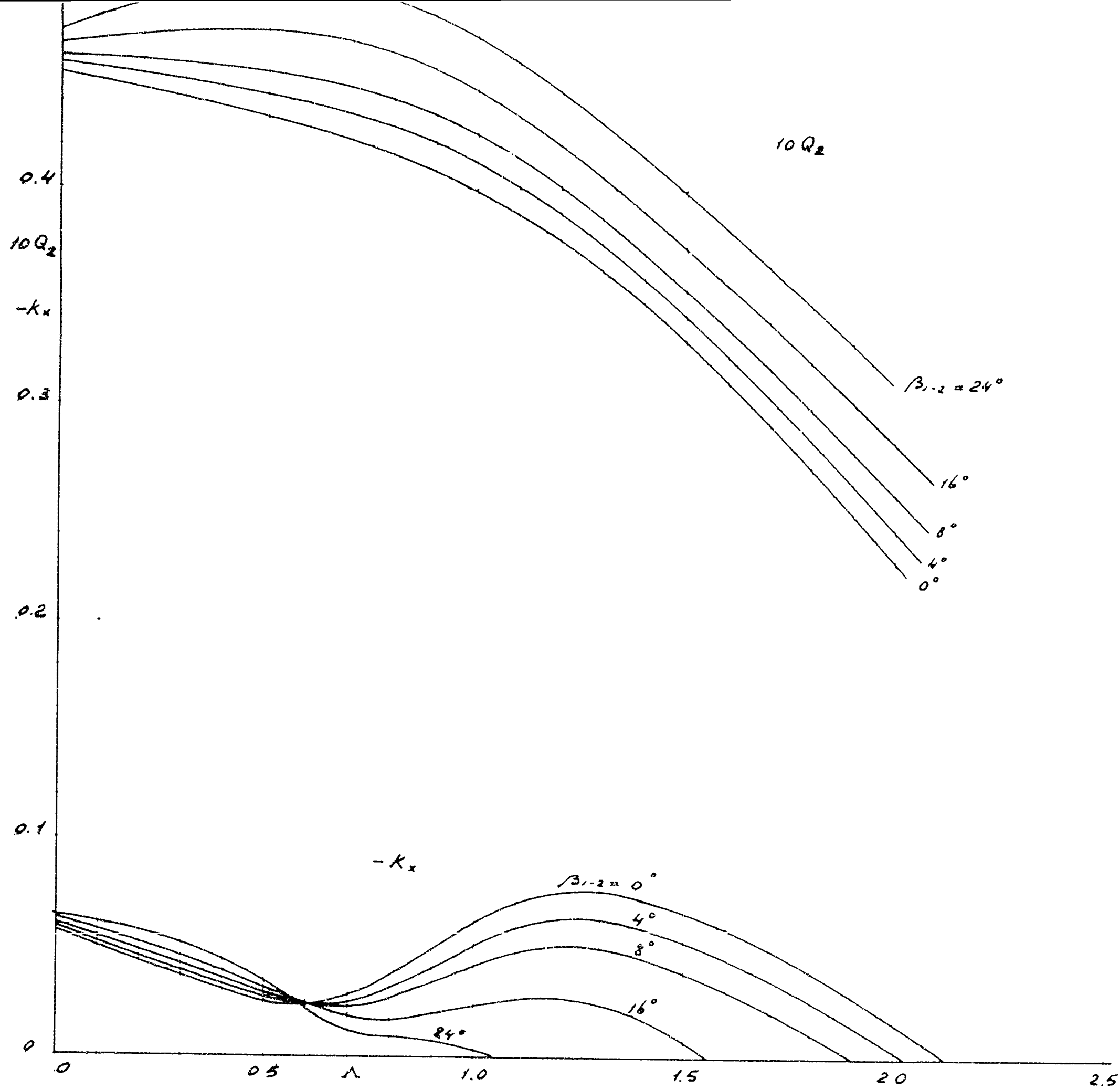
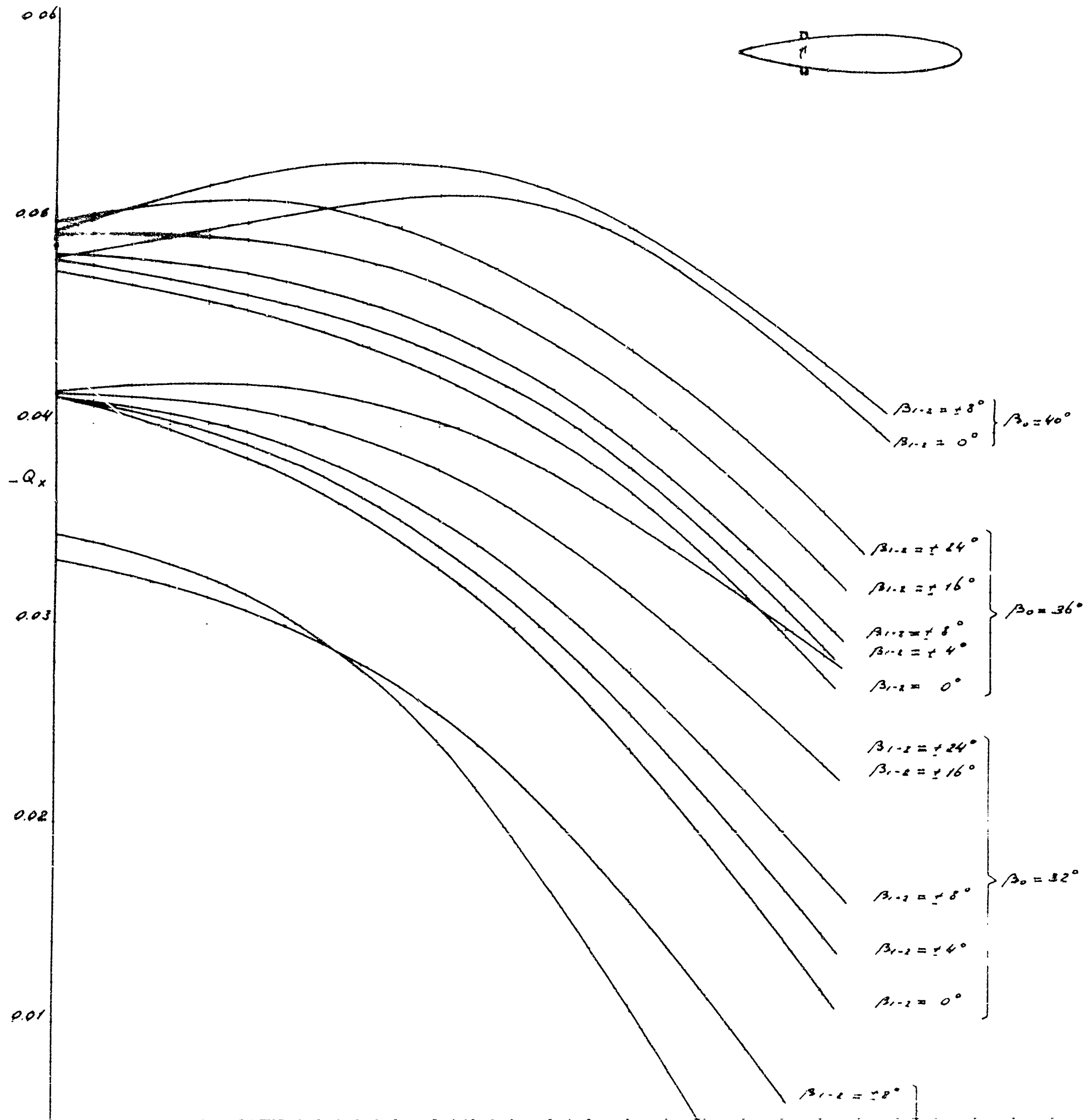


fig.2.3 3

A



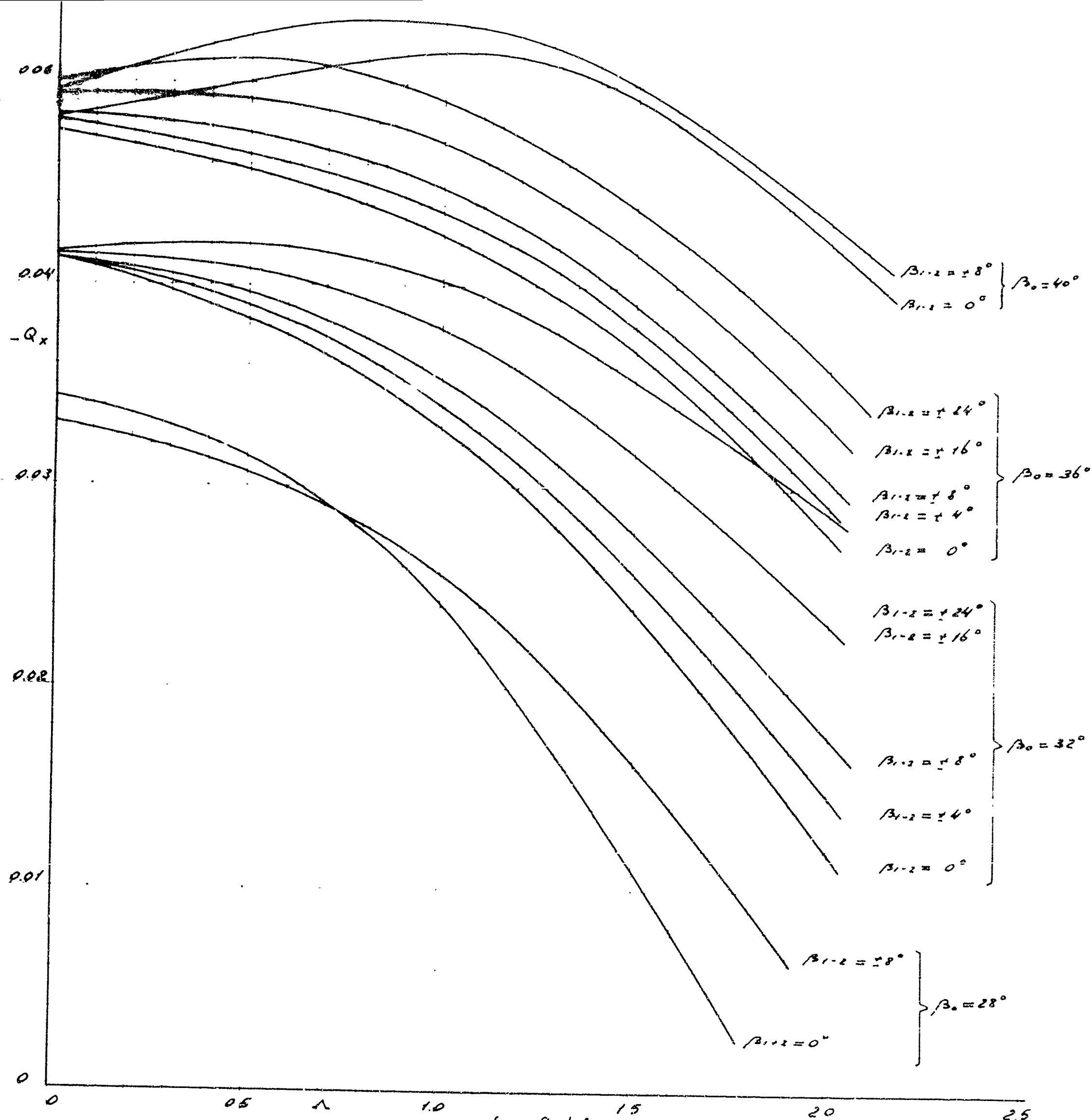
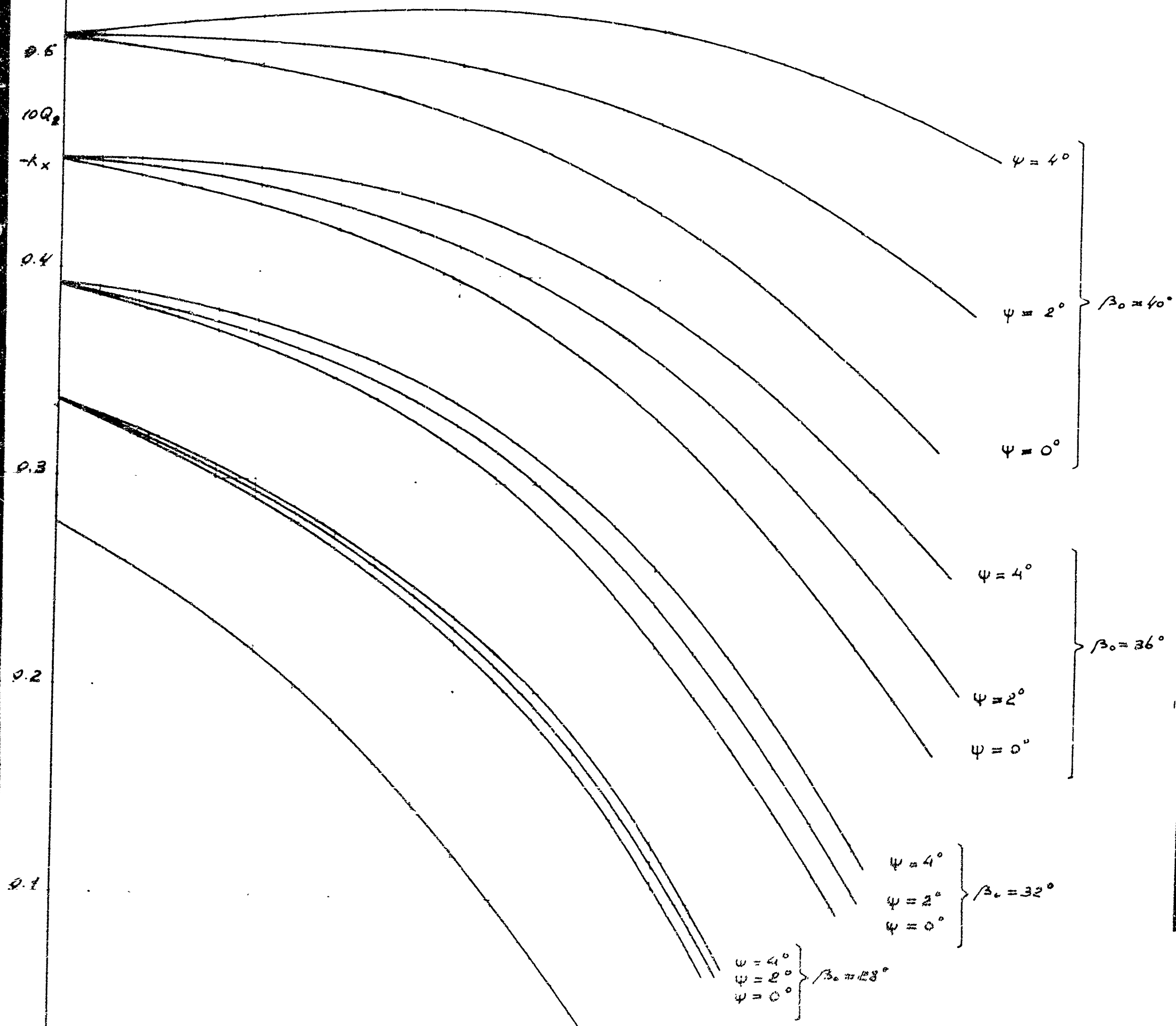


fig.2.41

$\beta_{1/2} = 20$



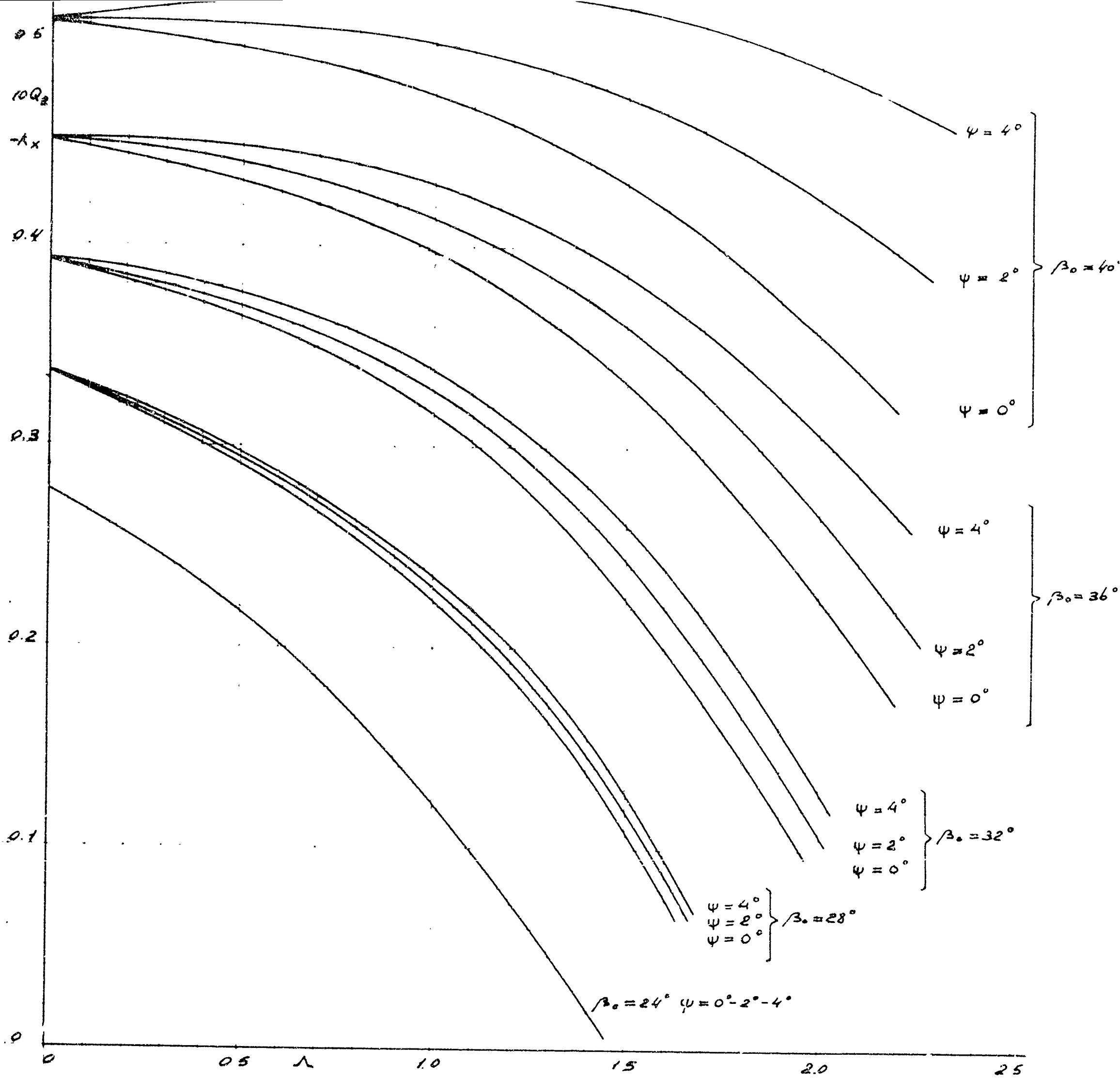
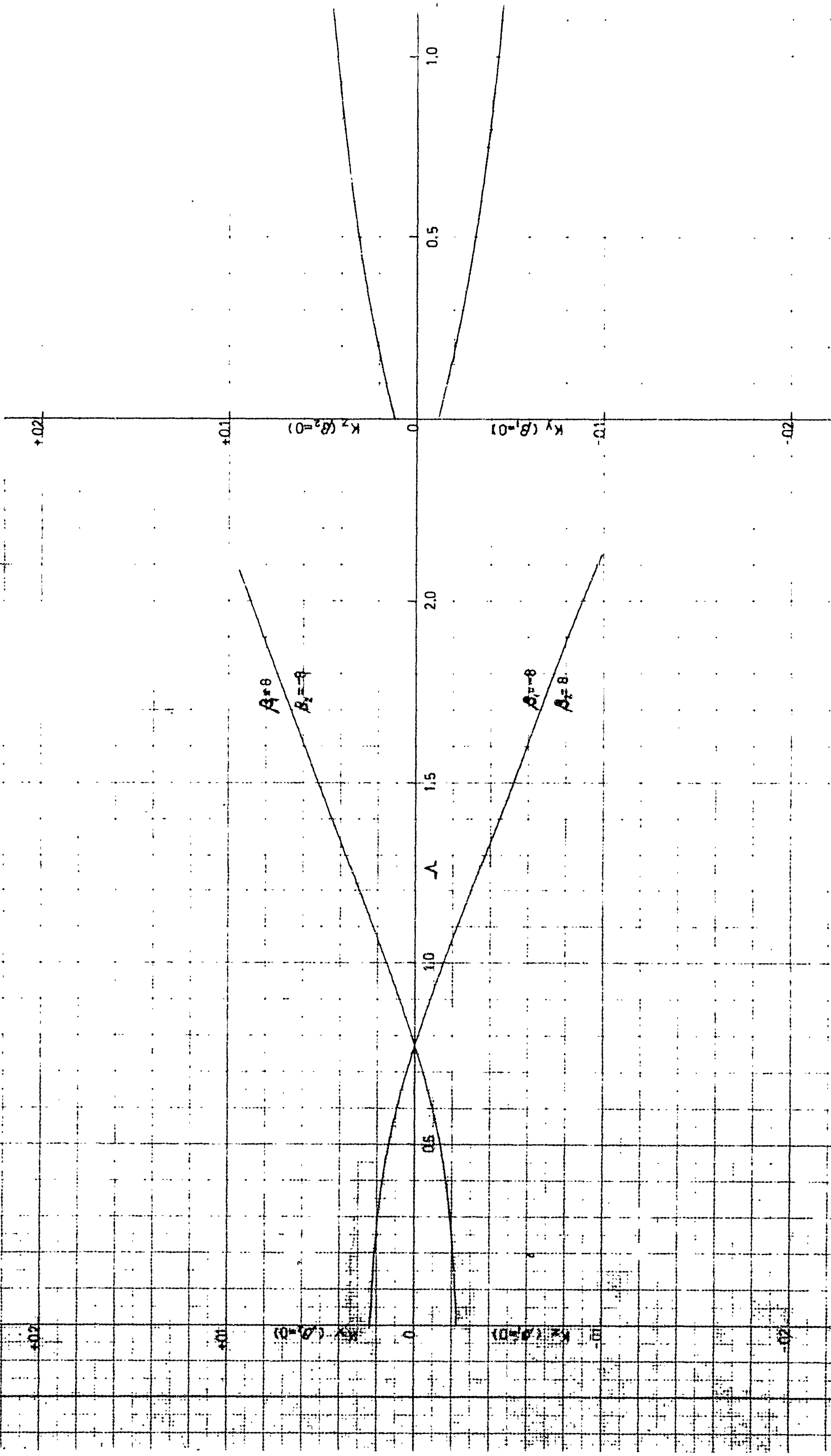
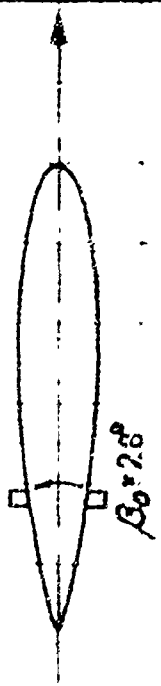


fig.2.5 1

-A

IMES





+0.2

+0.1

$K_1 (\beta_1, 0)$

0

$K_2 (\beta_2, 0)$

-0.1

-0.2

$\beta_1 = 8$

$\beta_2 = 8$

1.0

1.5

2.0

$\beta_1 = 8$

$\beta_2 = 8$

1.0

1.5

2.0

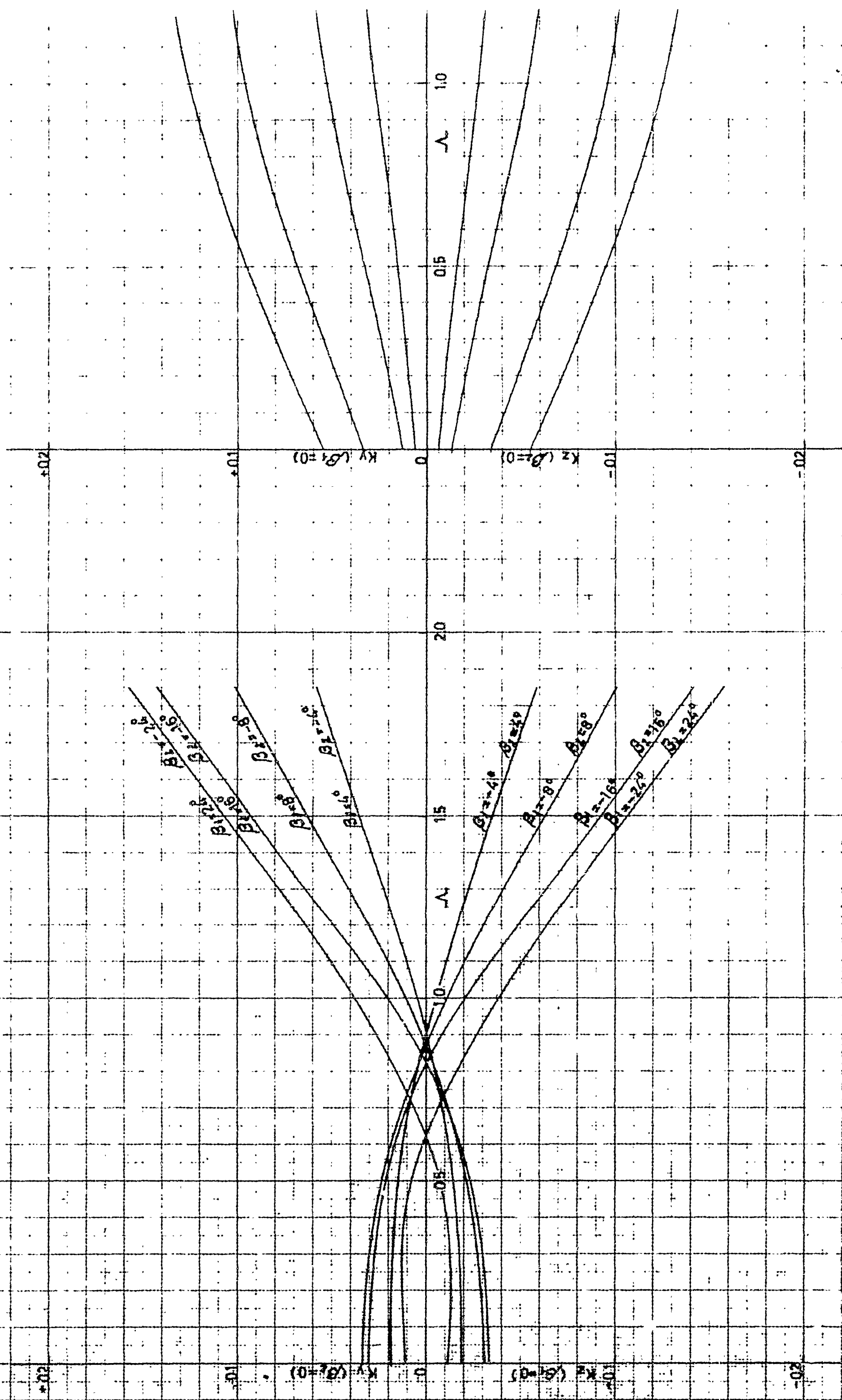
$\beta_1 = 8$

$\beta_2 = 8$

$\beta_1 = 8$

$\beta_2 = 8$

fig. 2.6.1



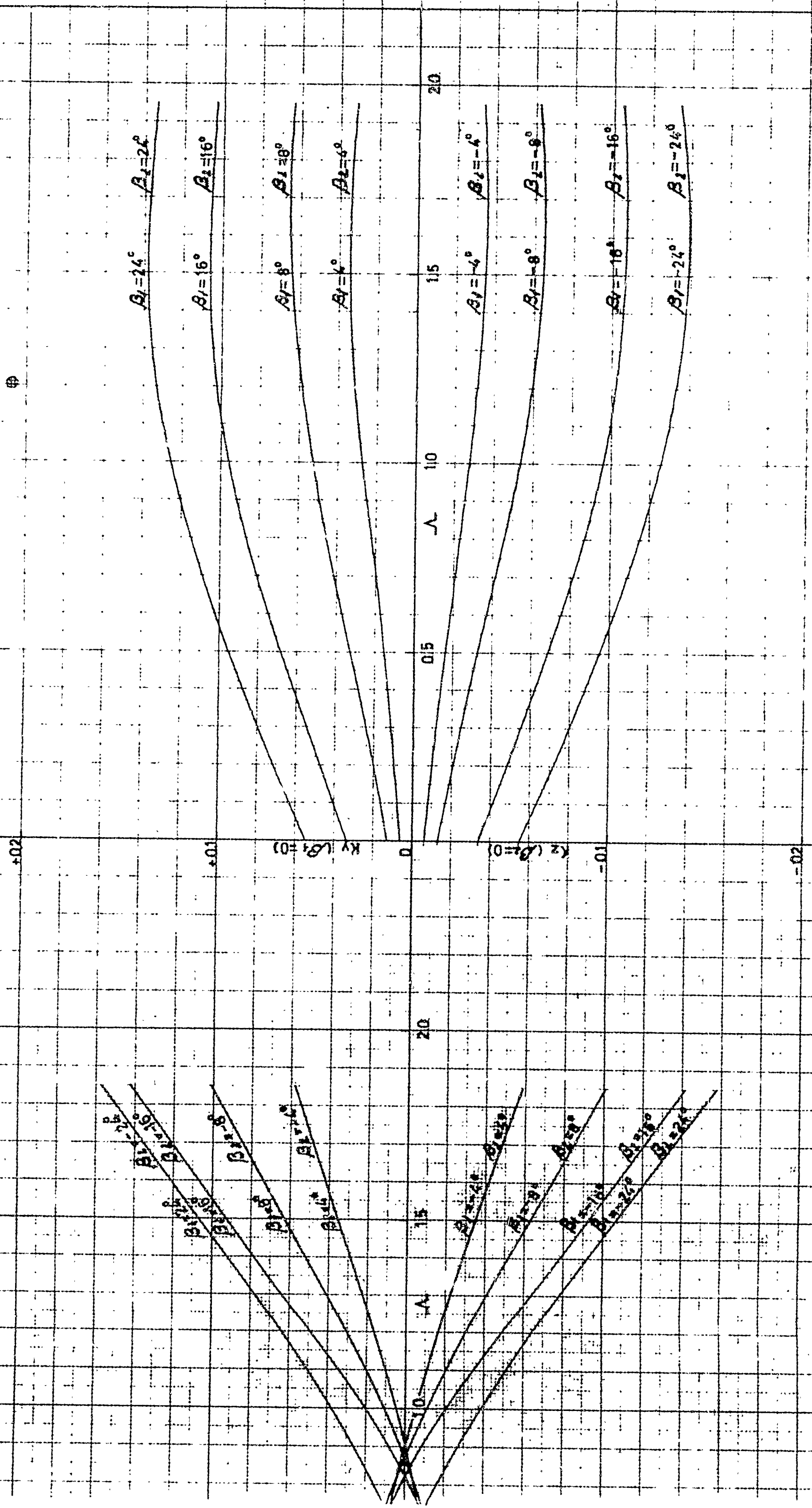
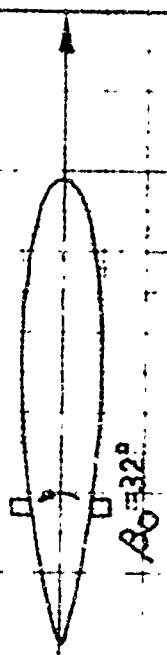
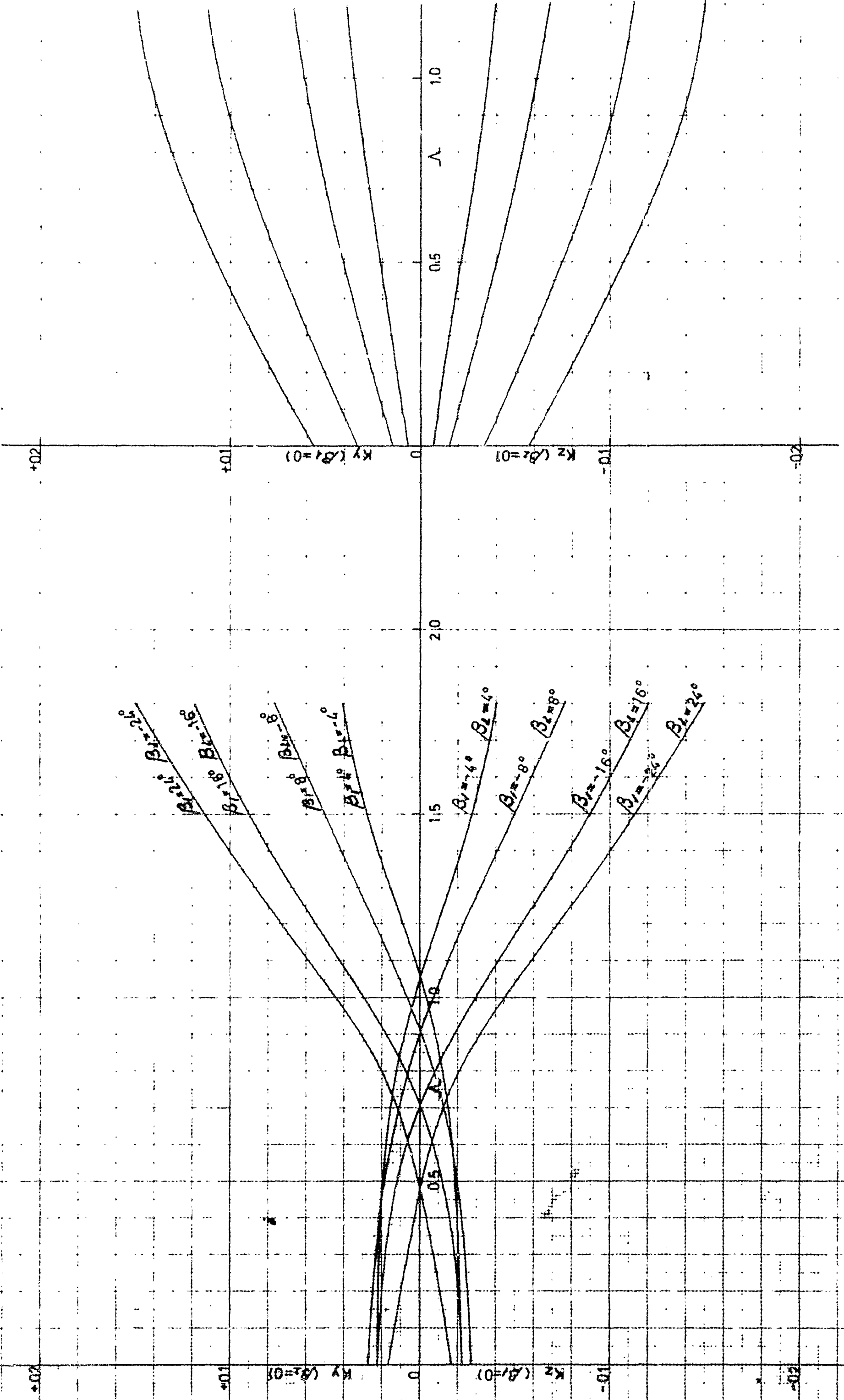


fig 2.6.2

A

FRAMES



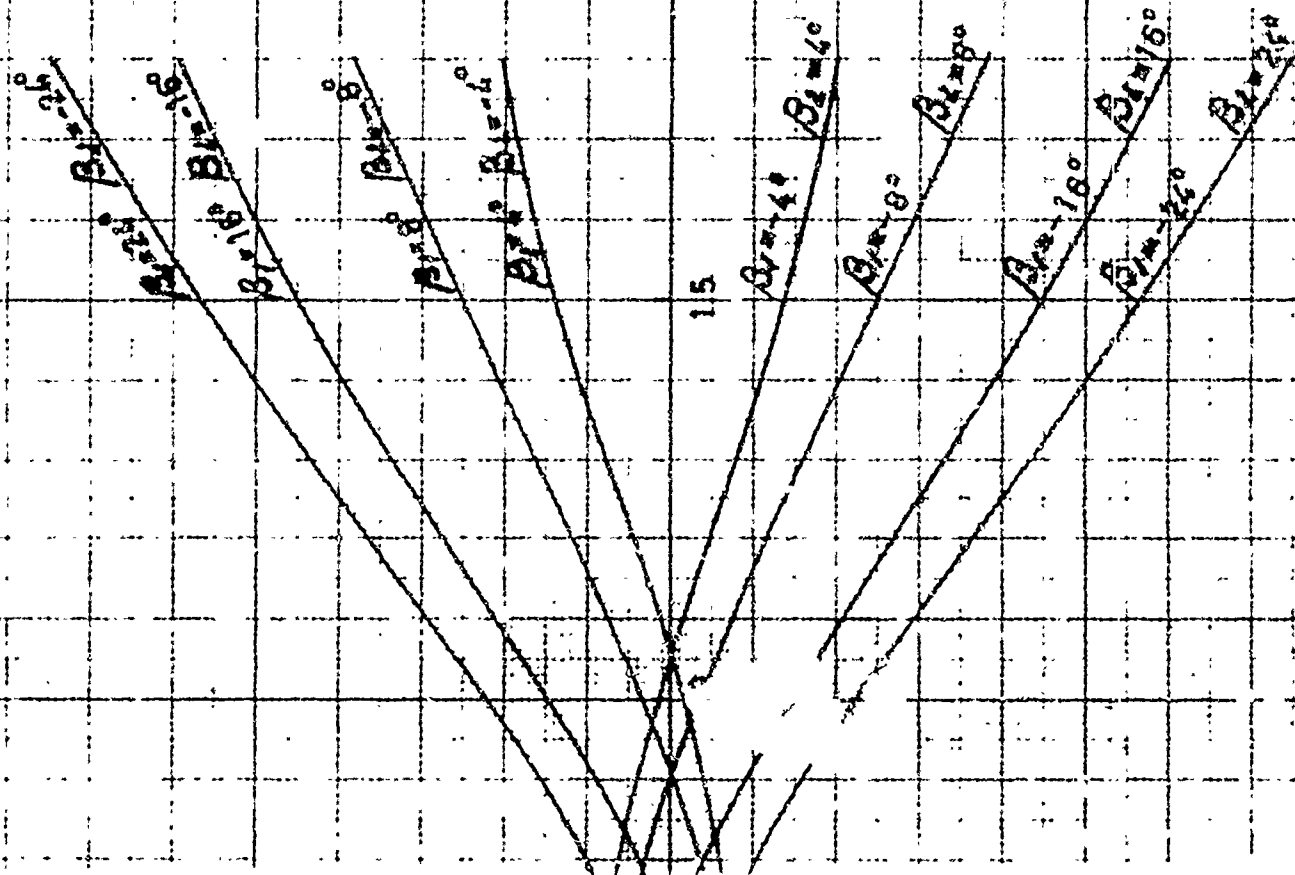
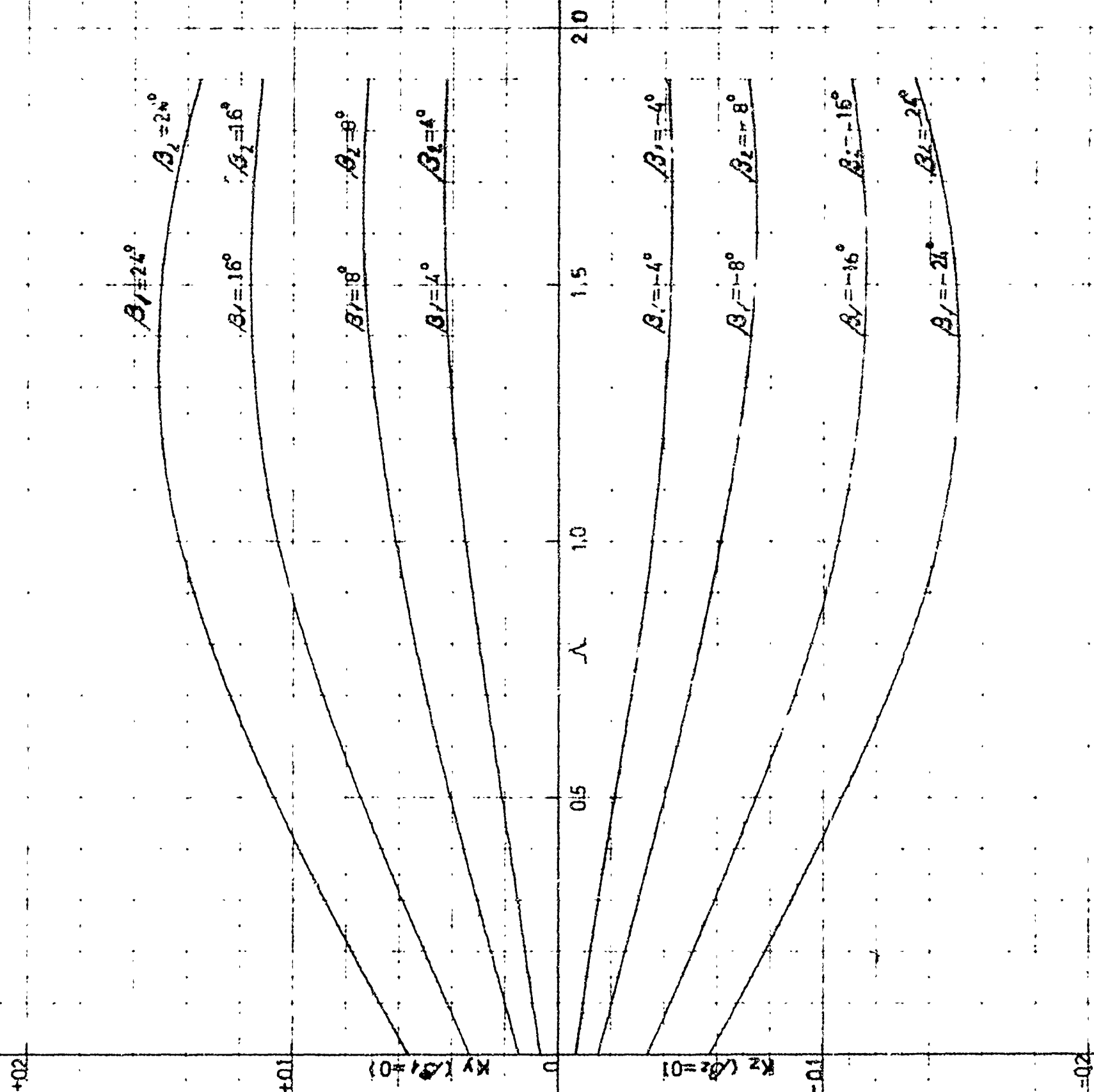
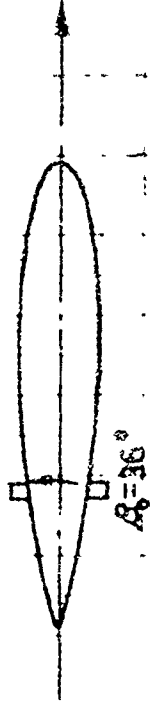
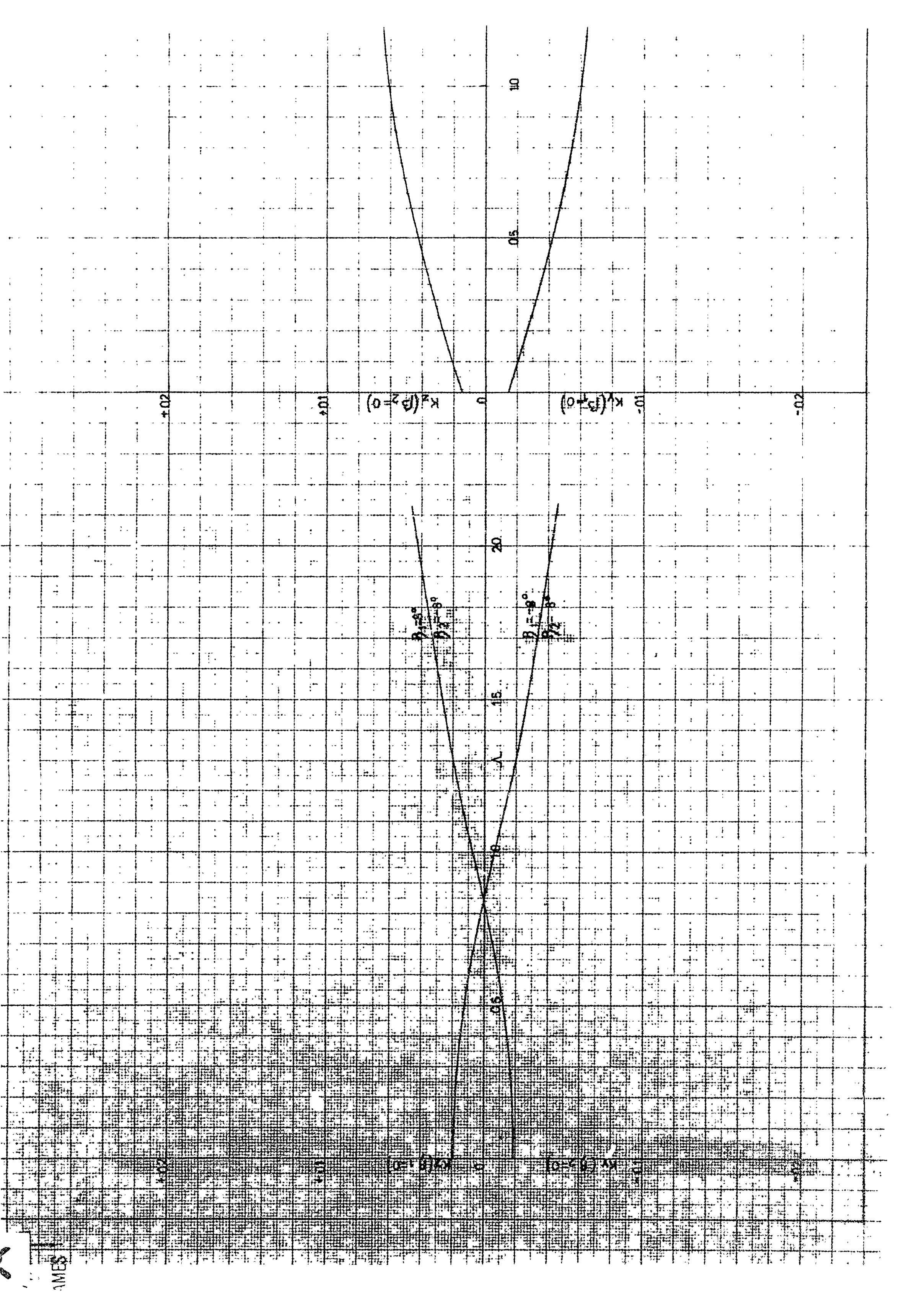
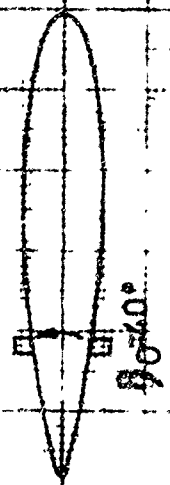


fig. 2.6.3



B



+02

+01

$K^2(\beta_2=0)$

0

$K^2(\beta_2=0)$

-02

20

15

10

05

20

15

10

$\beta_1=8^\circ$
 $\beta_2=8^\circ$

$\beta_1=8^\circ$
 $\beta_2=8^\circ$

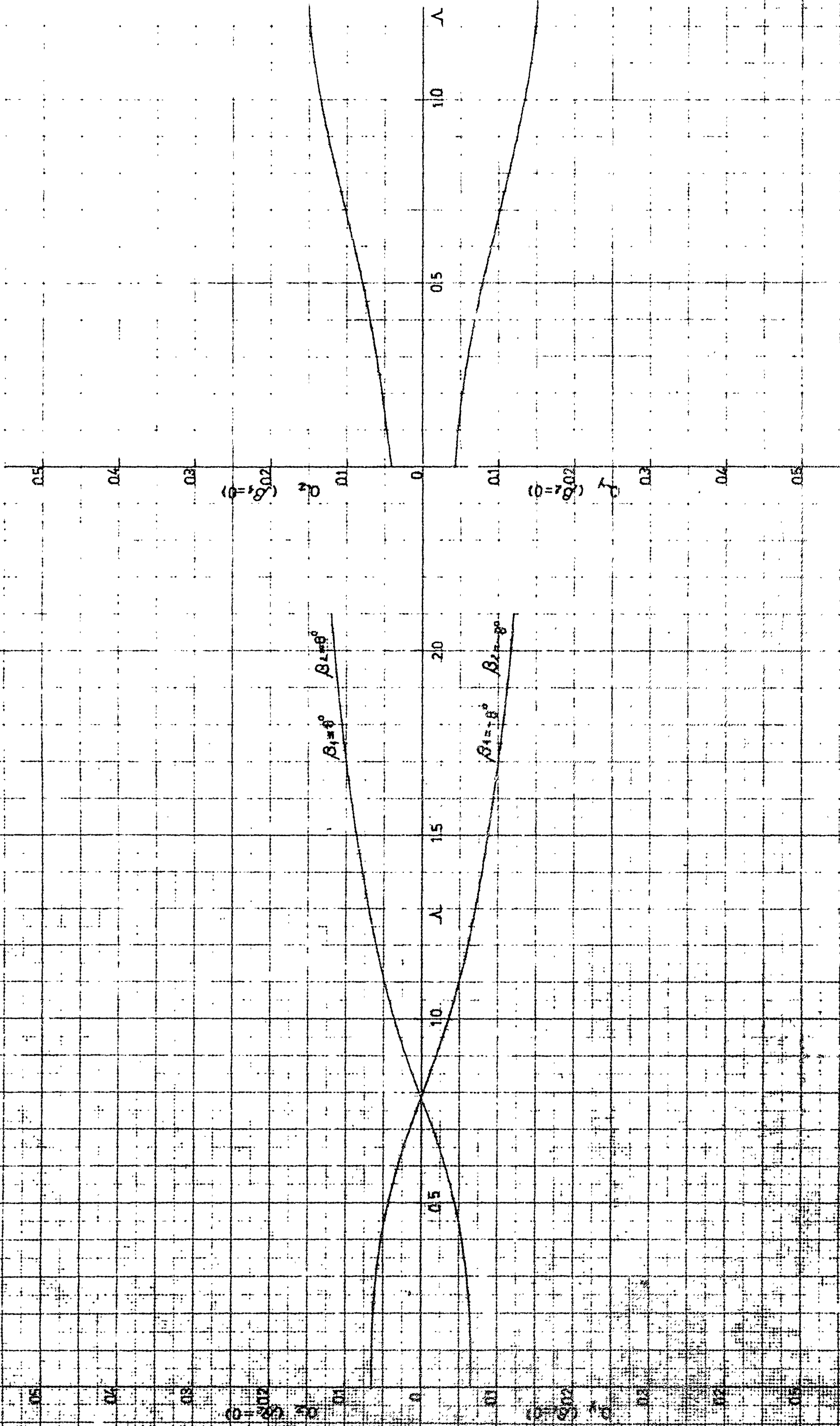
$\beta_1=8^\circ$
 $\beta_2=8^\circ$

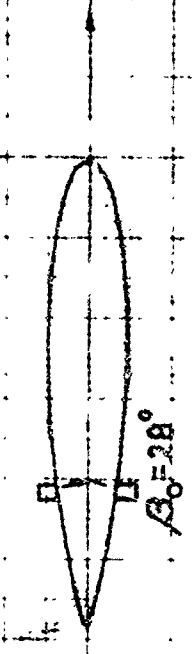
$\beta_1=8^\circ$
 $\beta_2=8^\circ$

fig. 2.6.4

A

RAMES





0.5
0.4
0.3
0.2
0.1
0
0.1
0.2
0.3
0.4
0.5

$(\theta = 0)$

θ

$(\theta = 0)$

θ

$\beta_1 = 8^\circ$ $\beta_2 = 8^\circ$

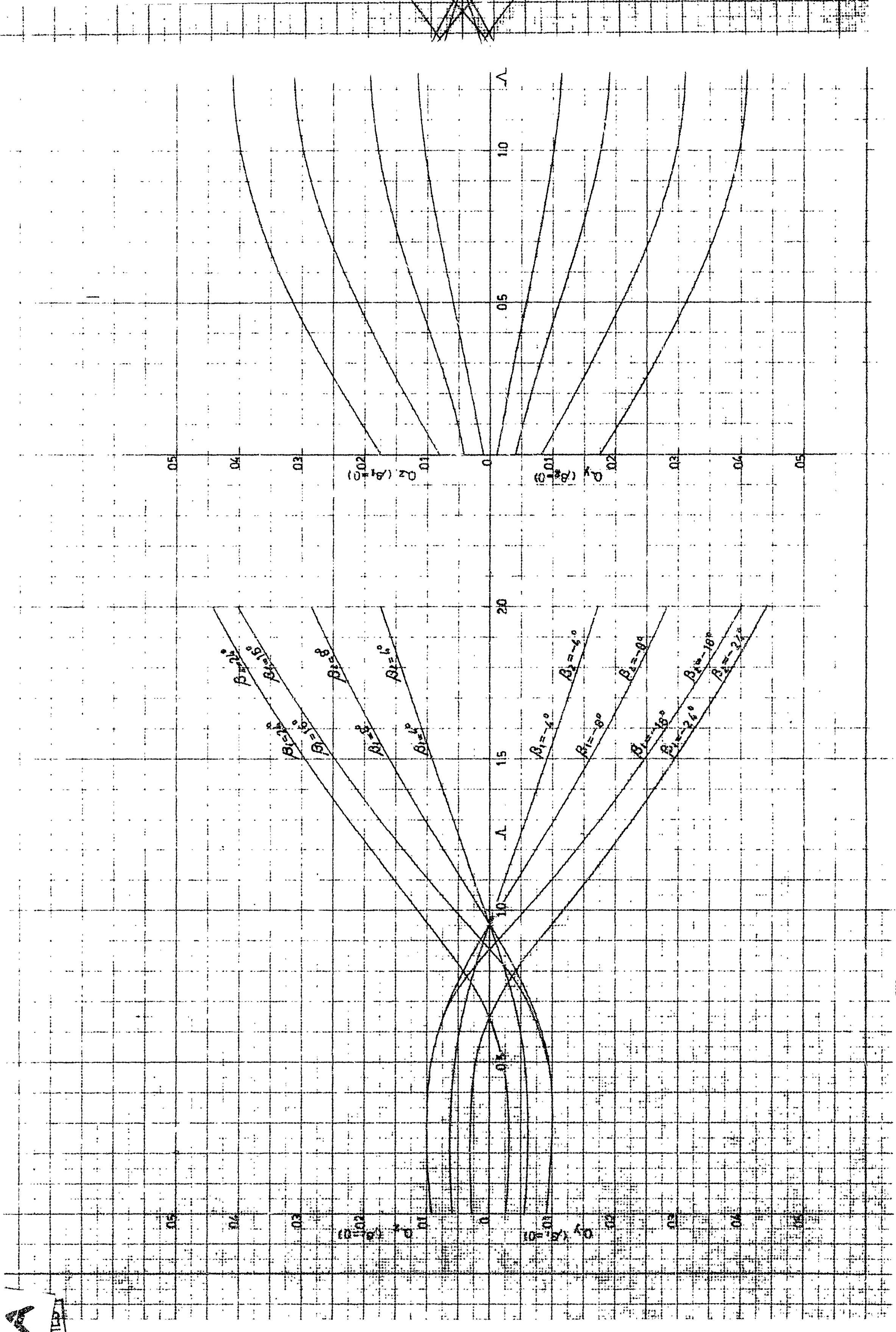
$\beta_1 = 8^\circ$ $\beta_2 = 8^\circ$

$\beta_1 = 8^\circ$ $\beta_2 = 8^\circ$

$\beta_1 = 8^\circ$ $\beta_2 = 8^\circ$

fig. 2.7.1

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3

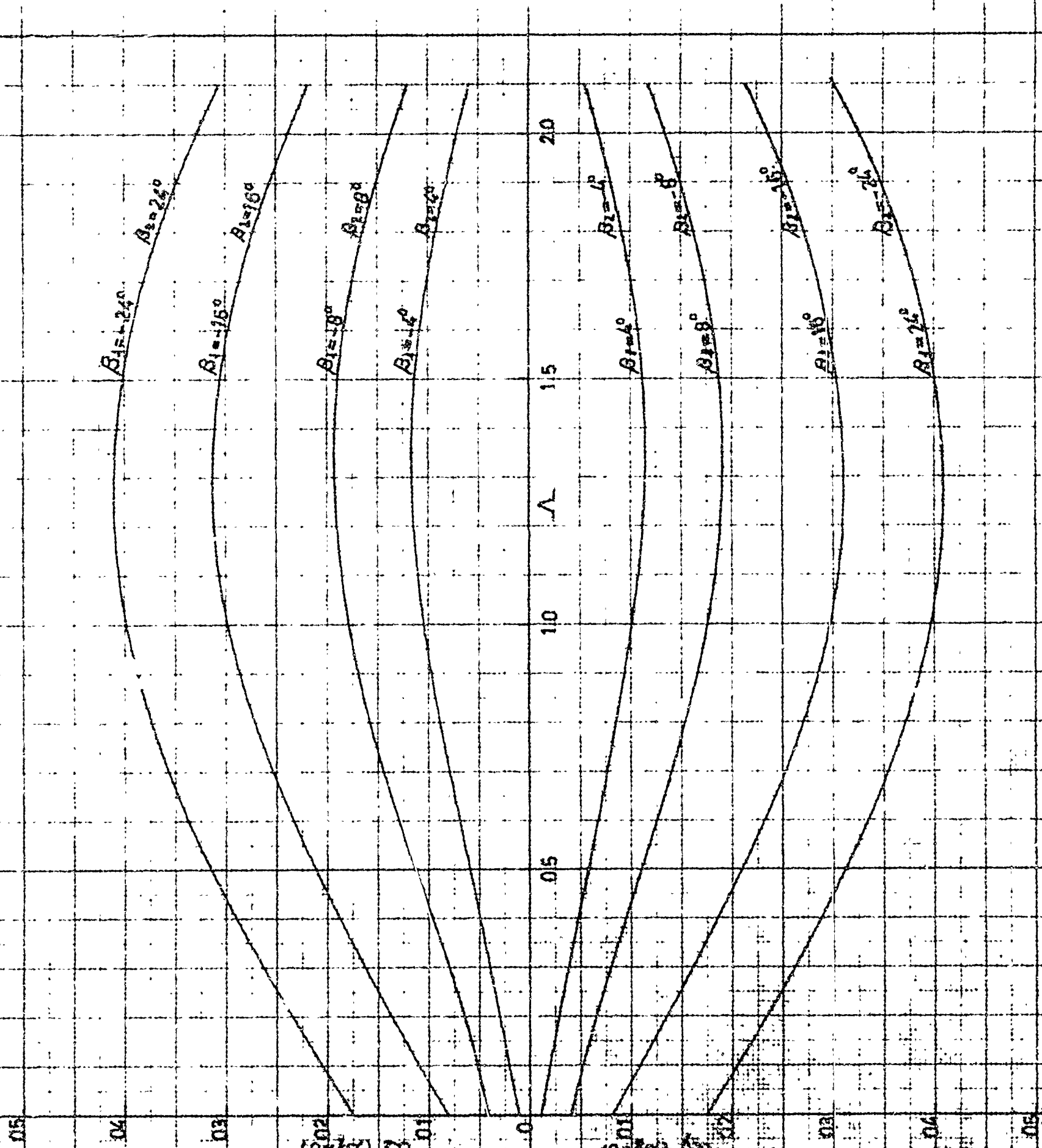
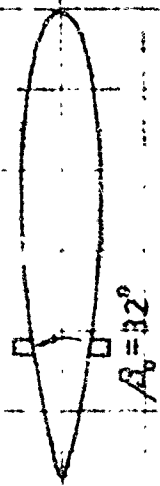
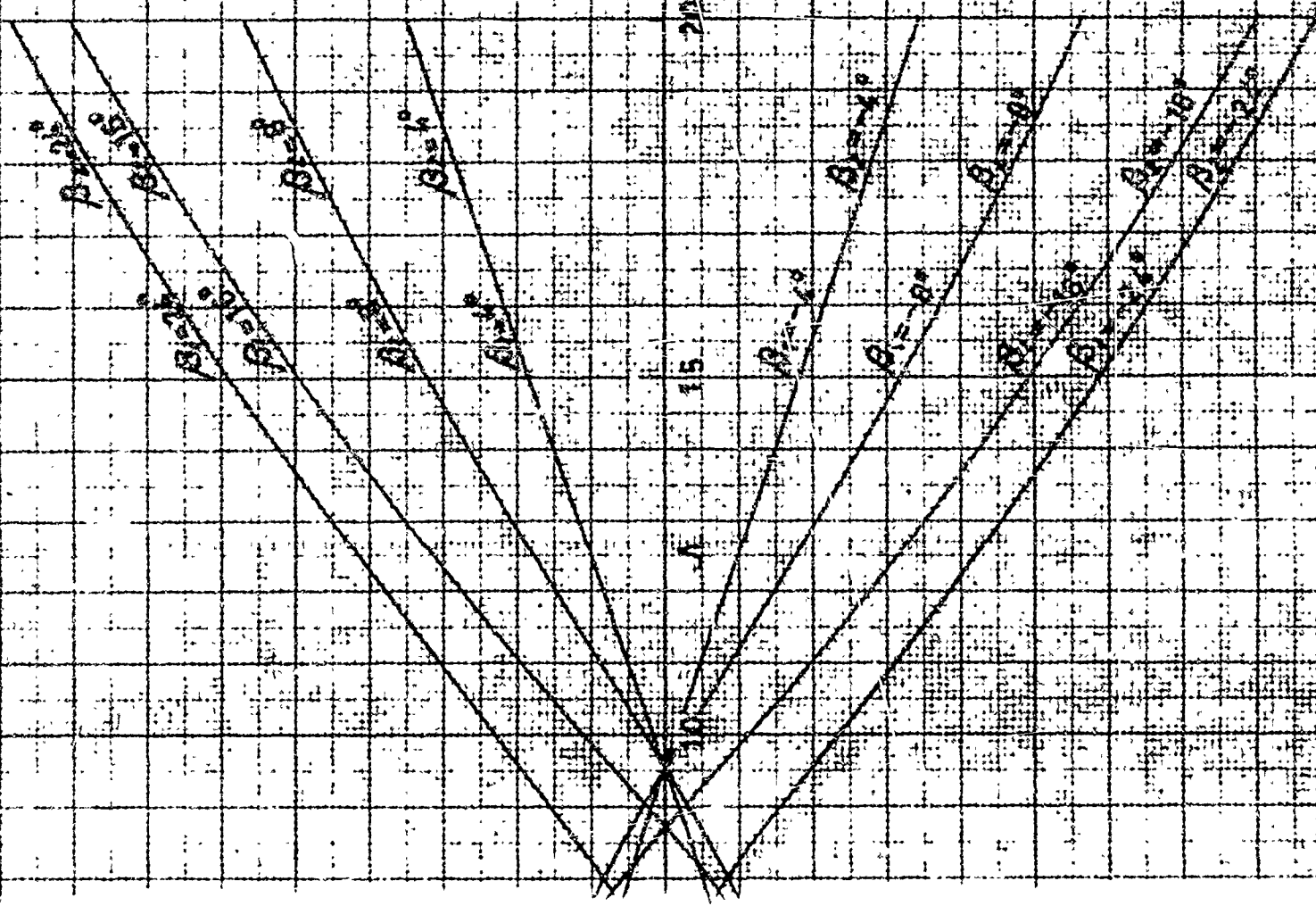
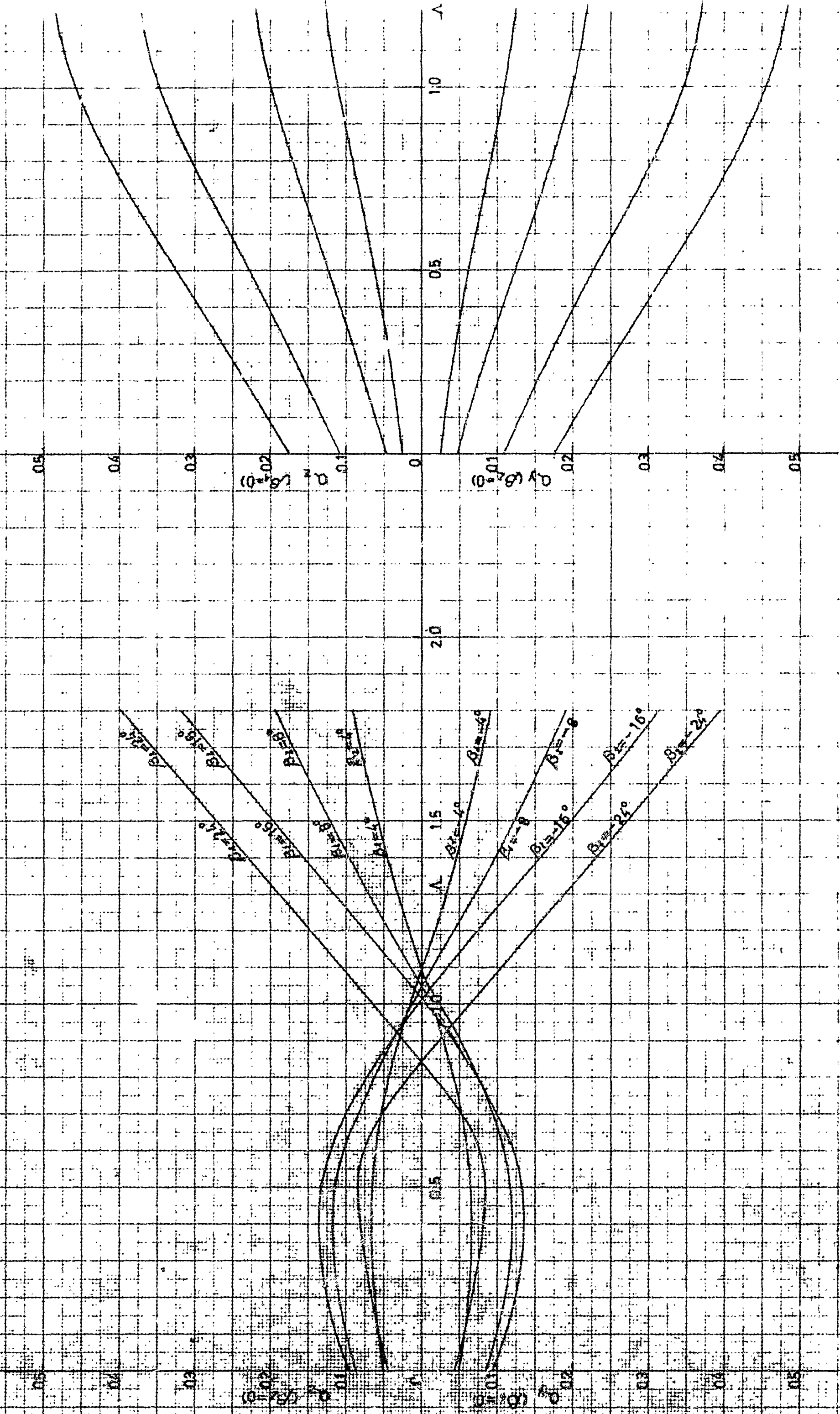
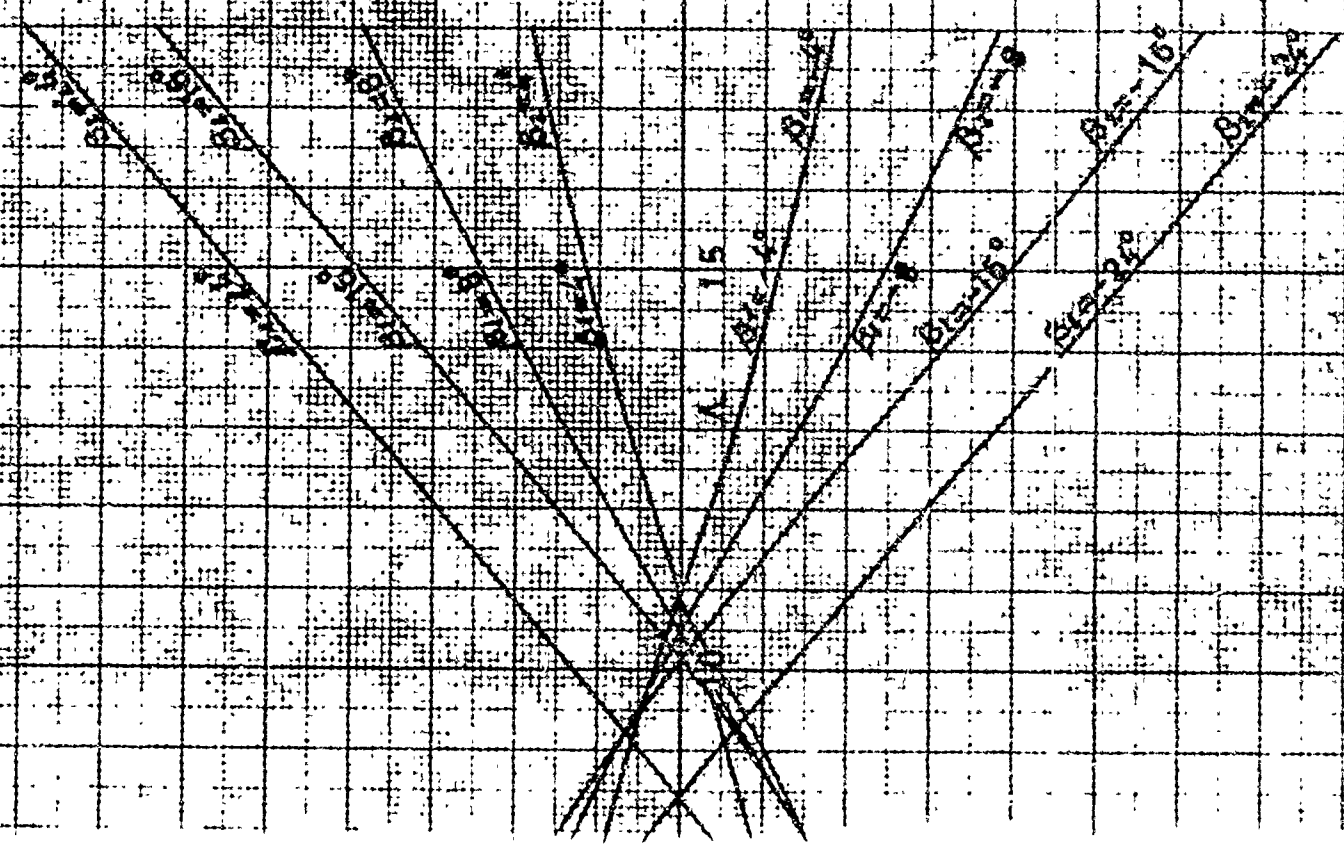
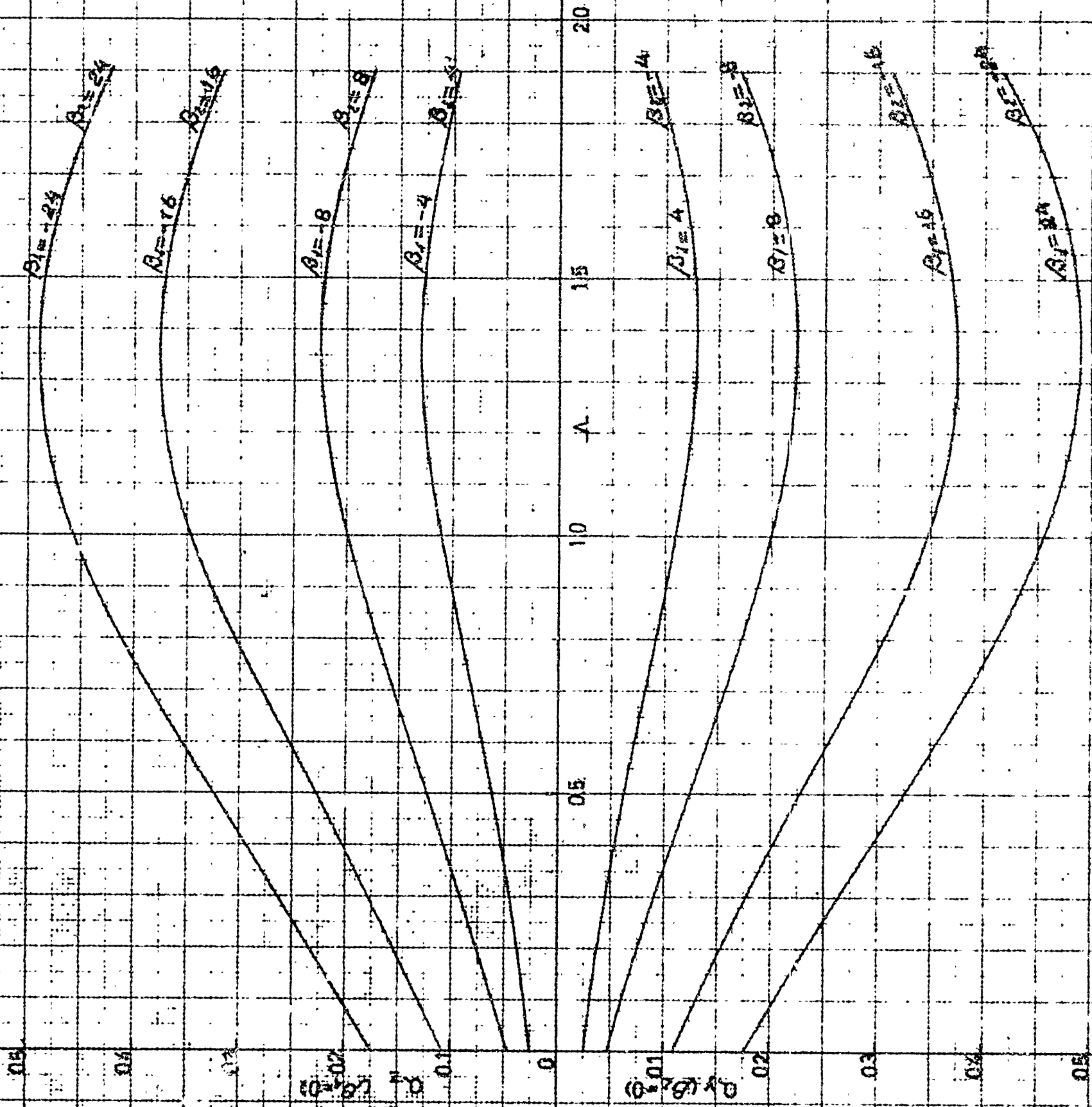
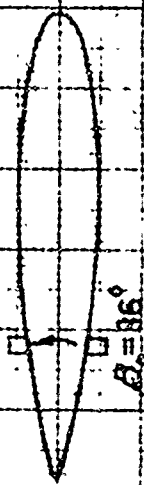


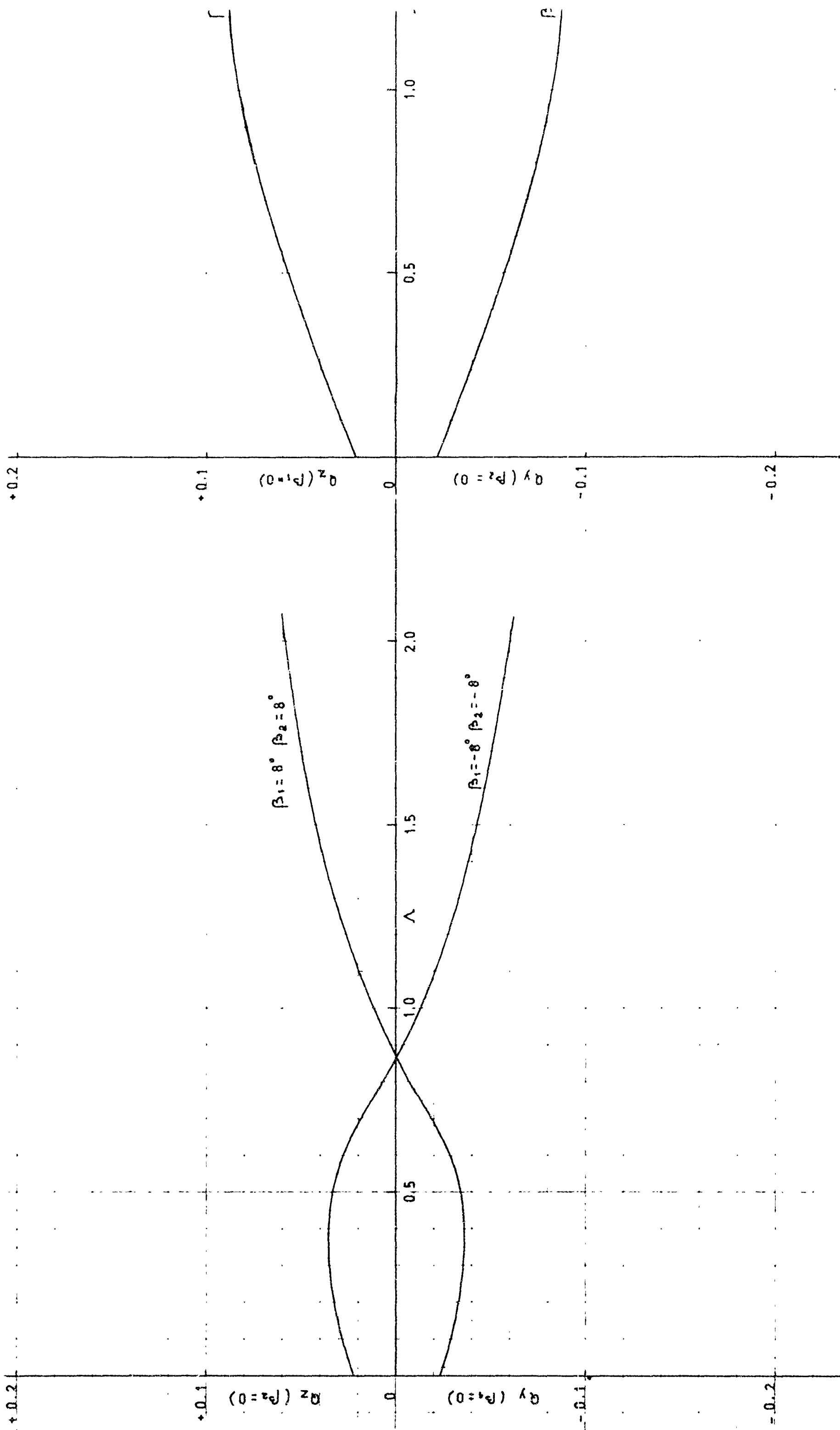
fig. 2.7.2





B





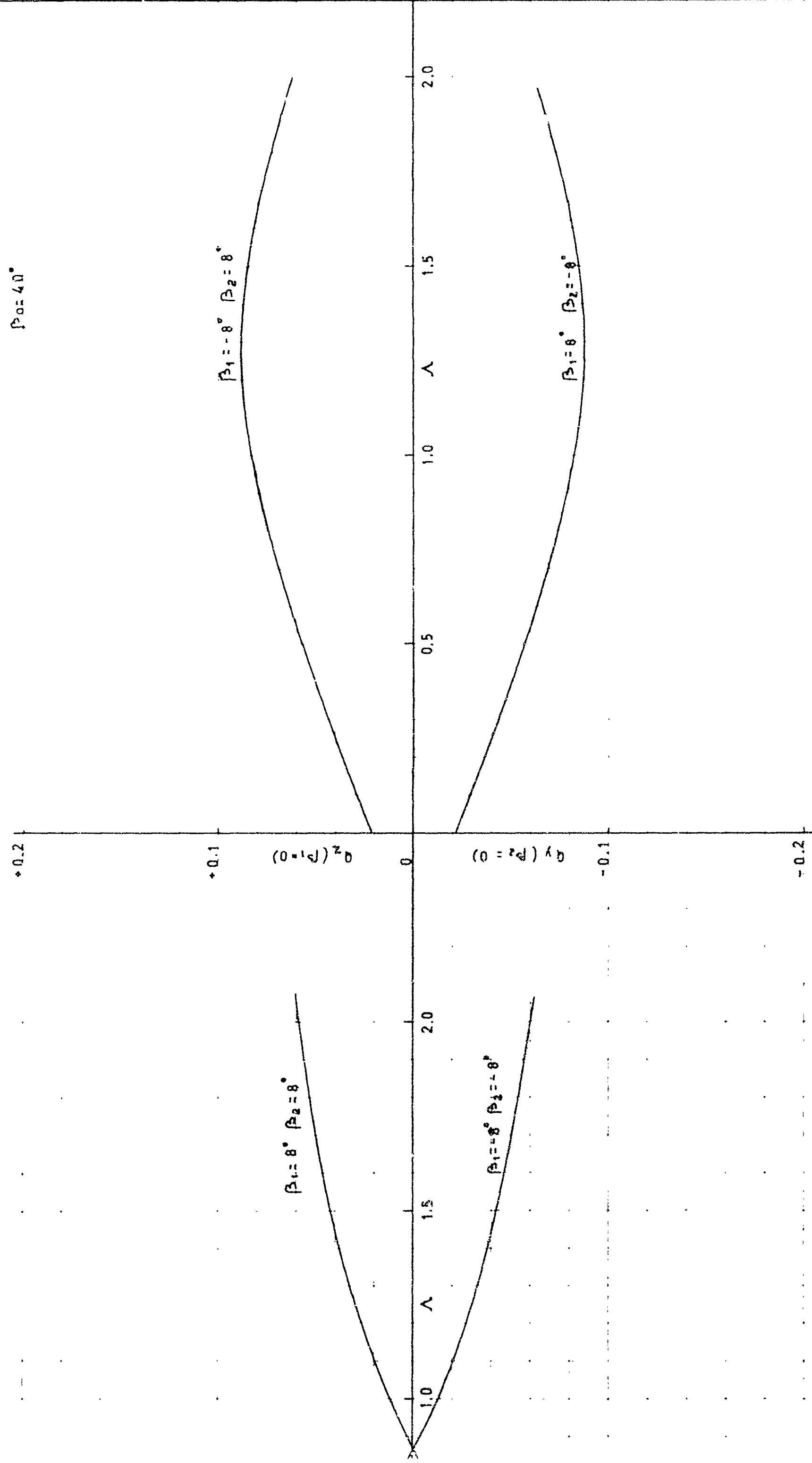
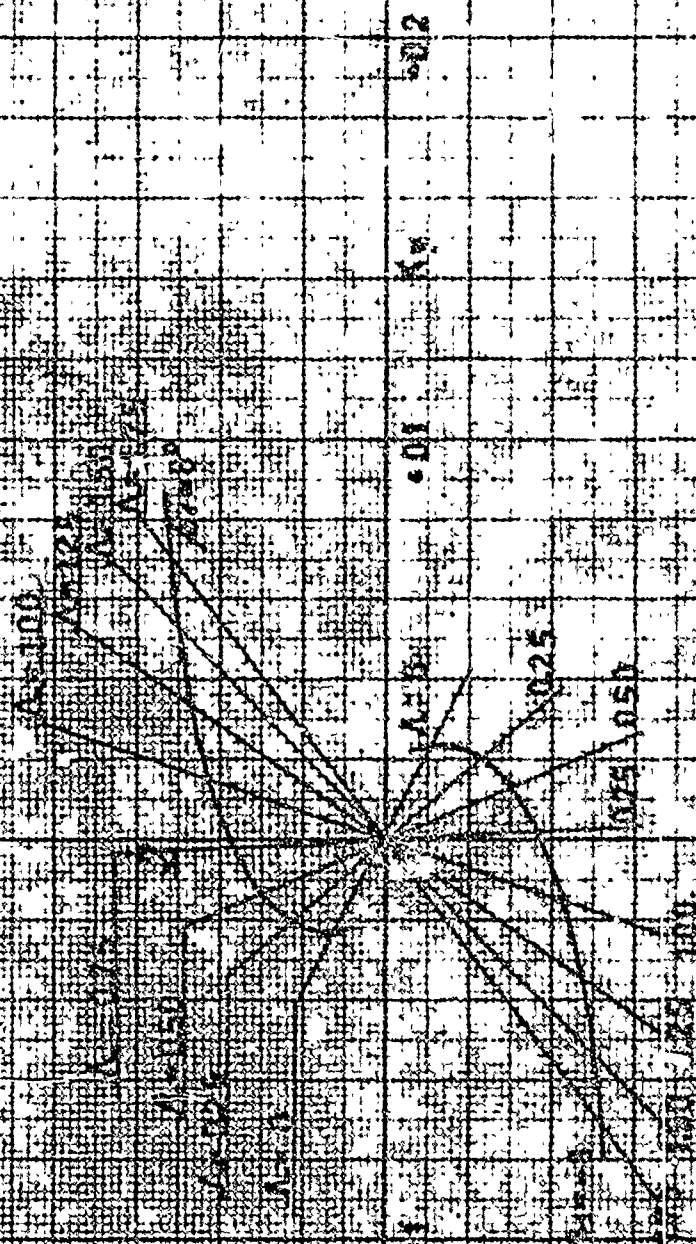
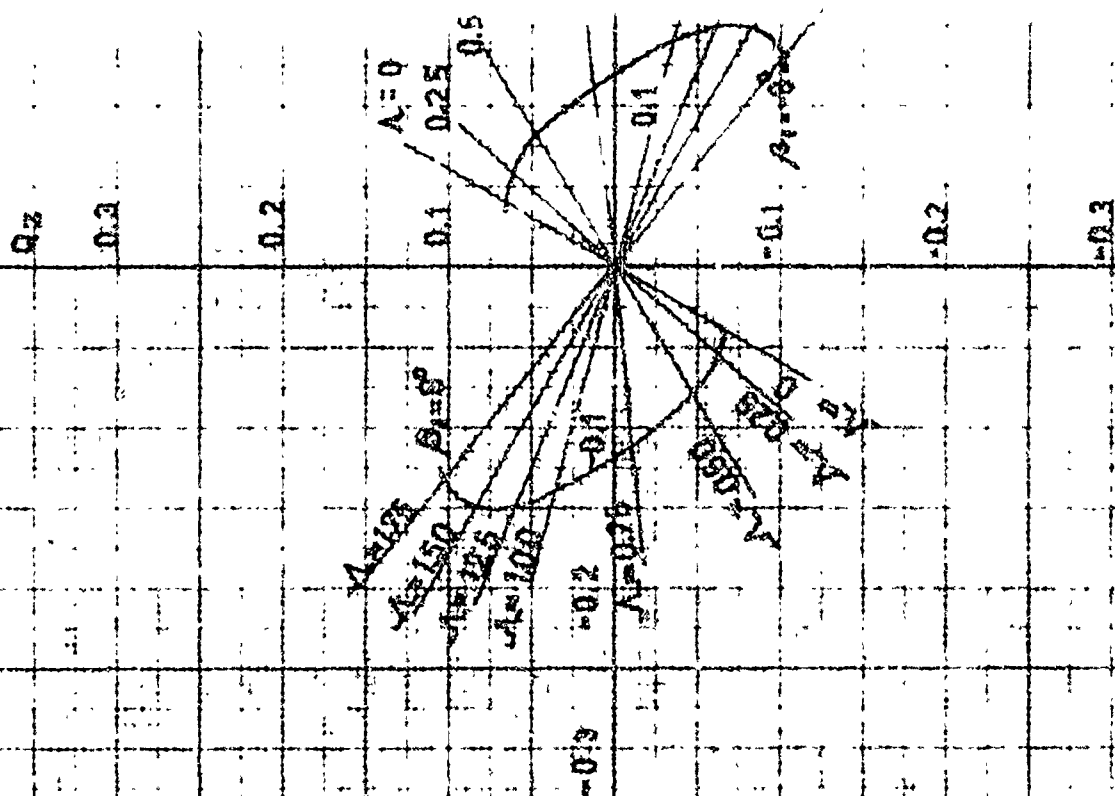


fig 2 7 4

A

S



3

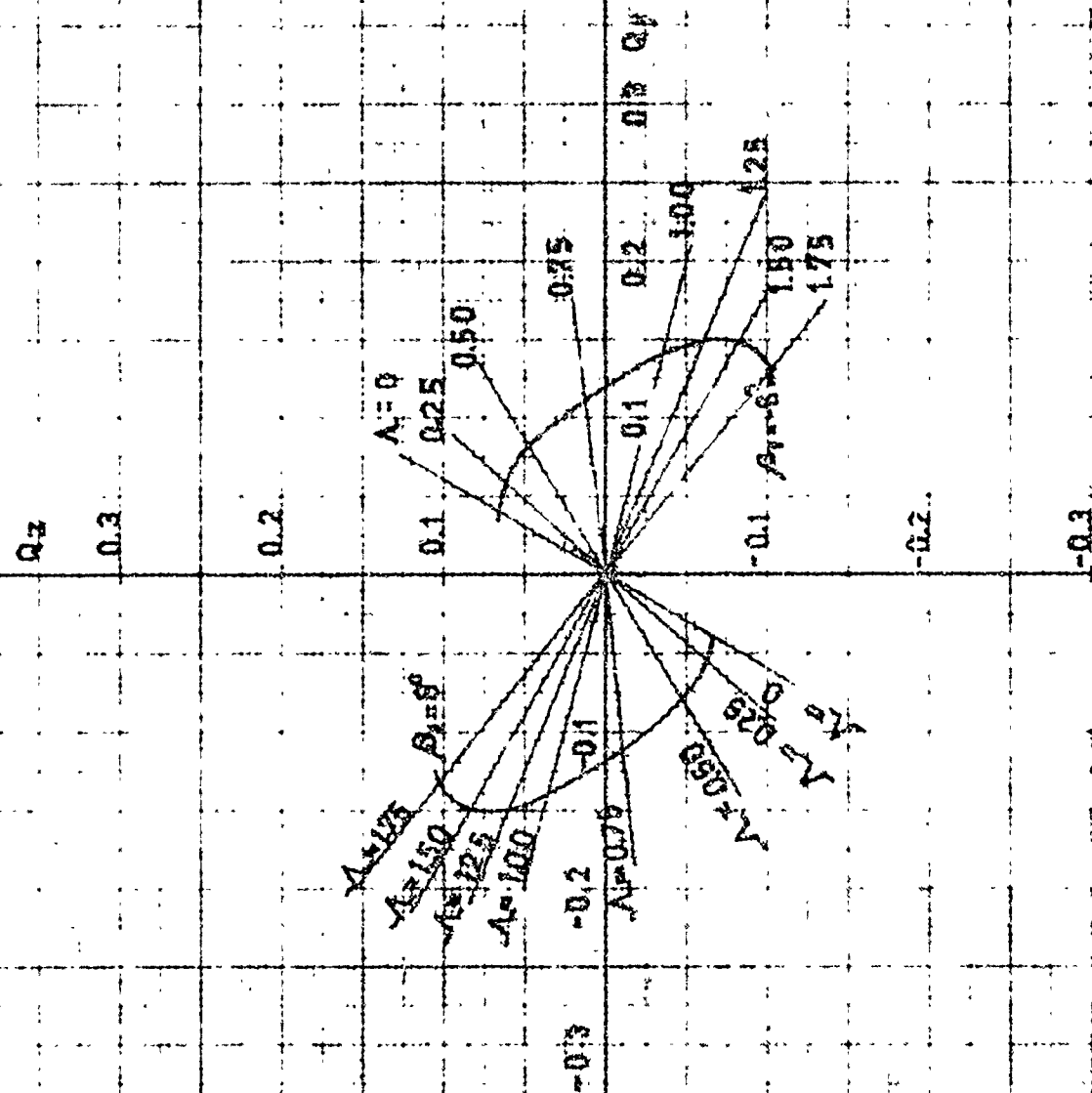
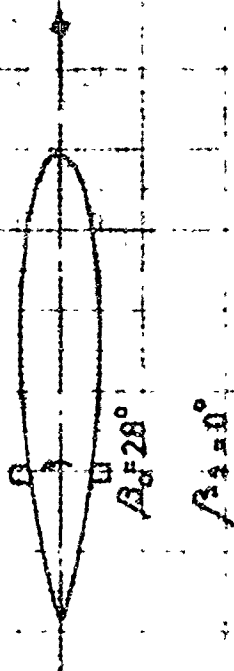
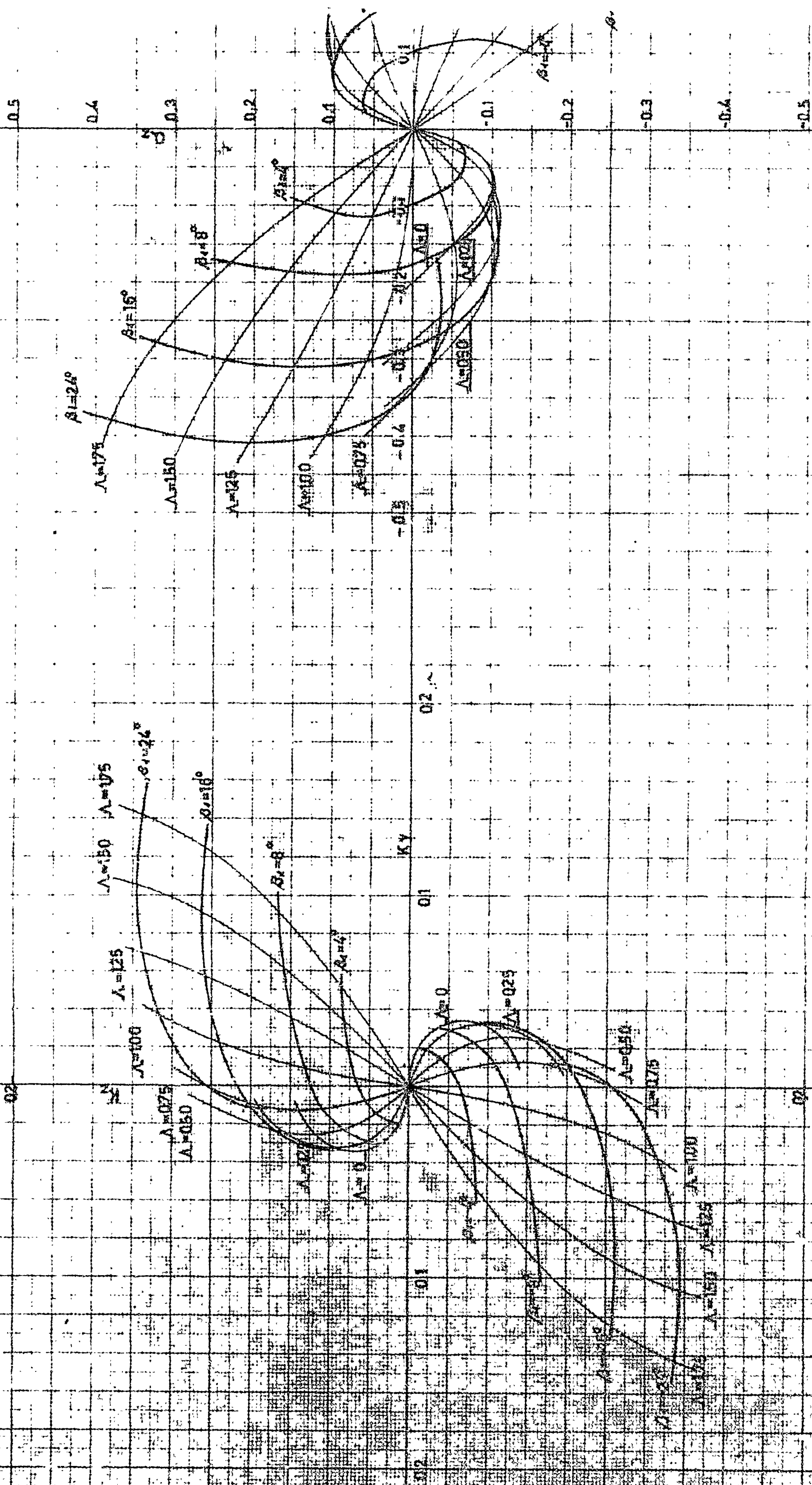


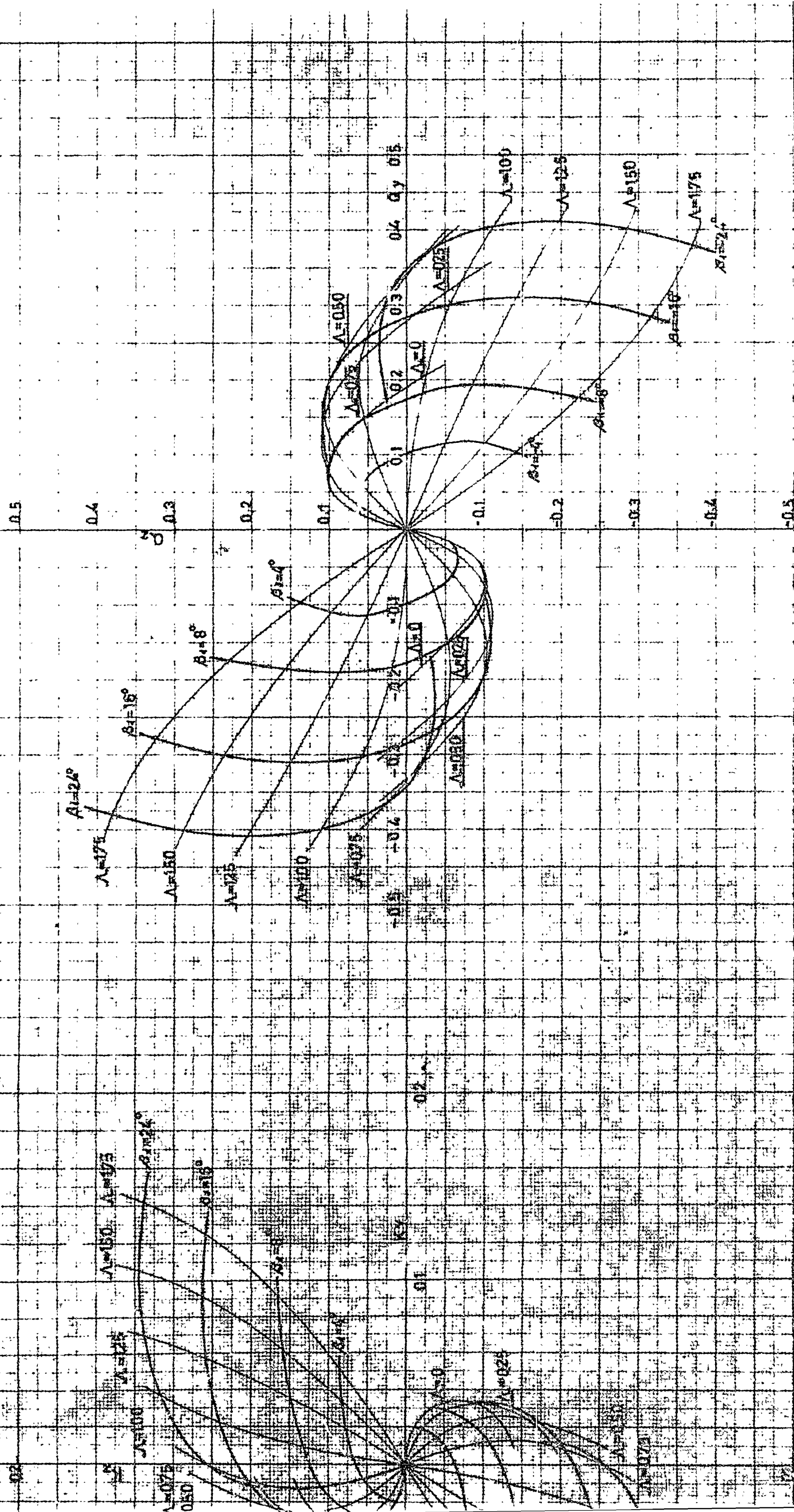
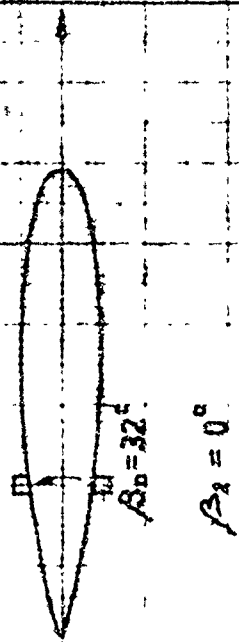
fig. 2.8.1

A

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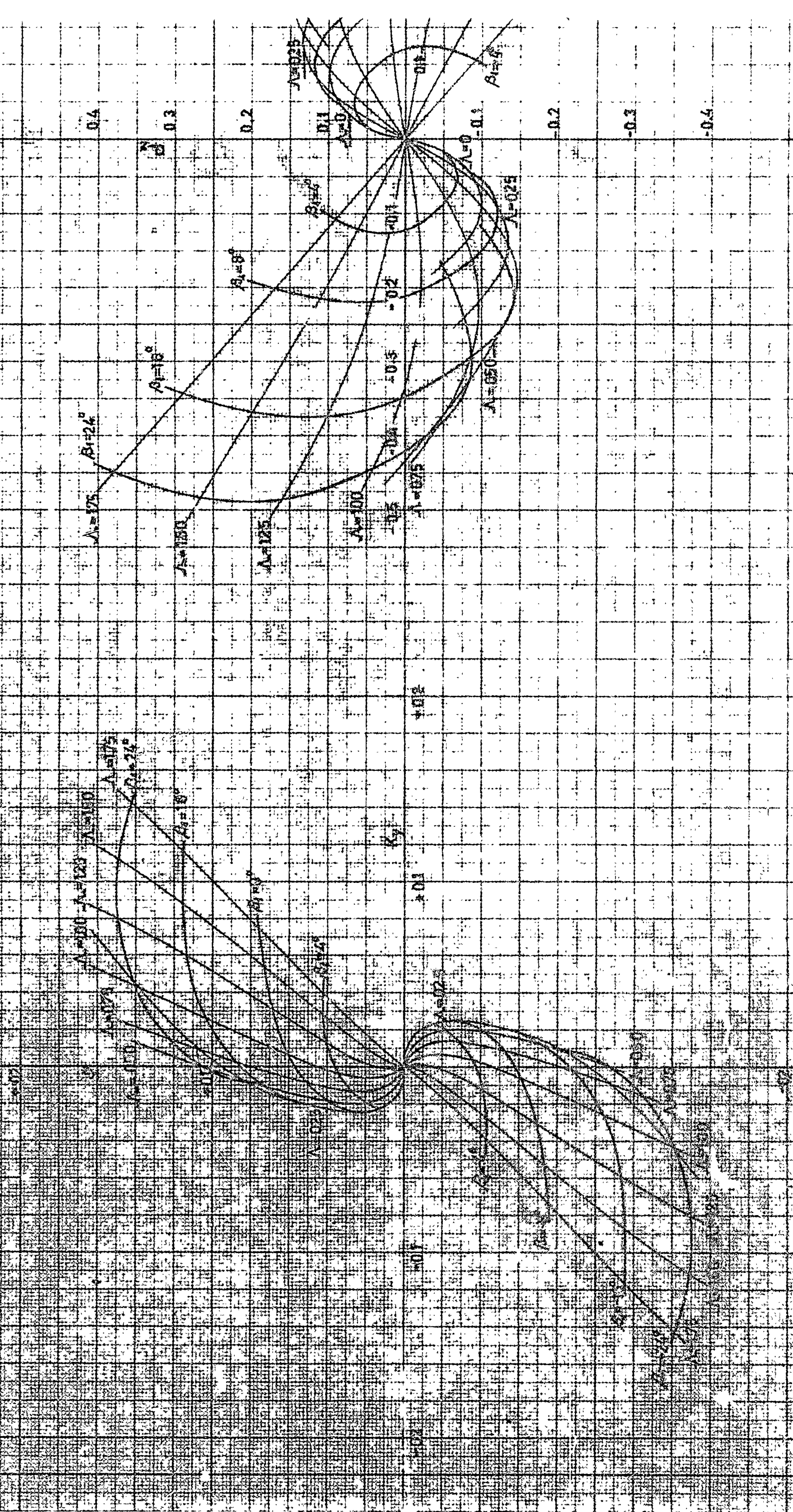


8



A

S



3

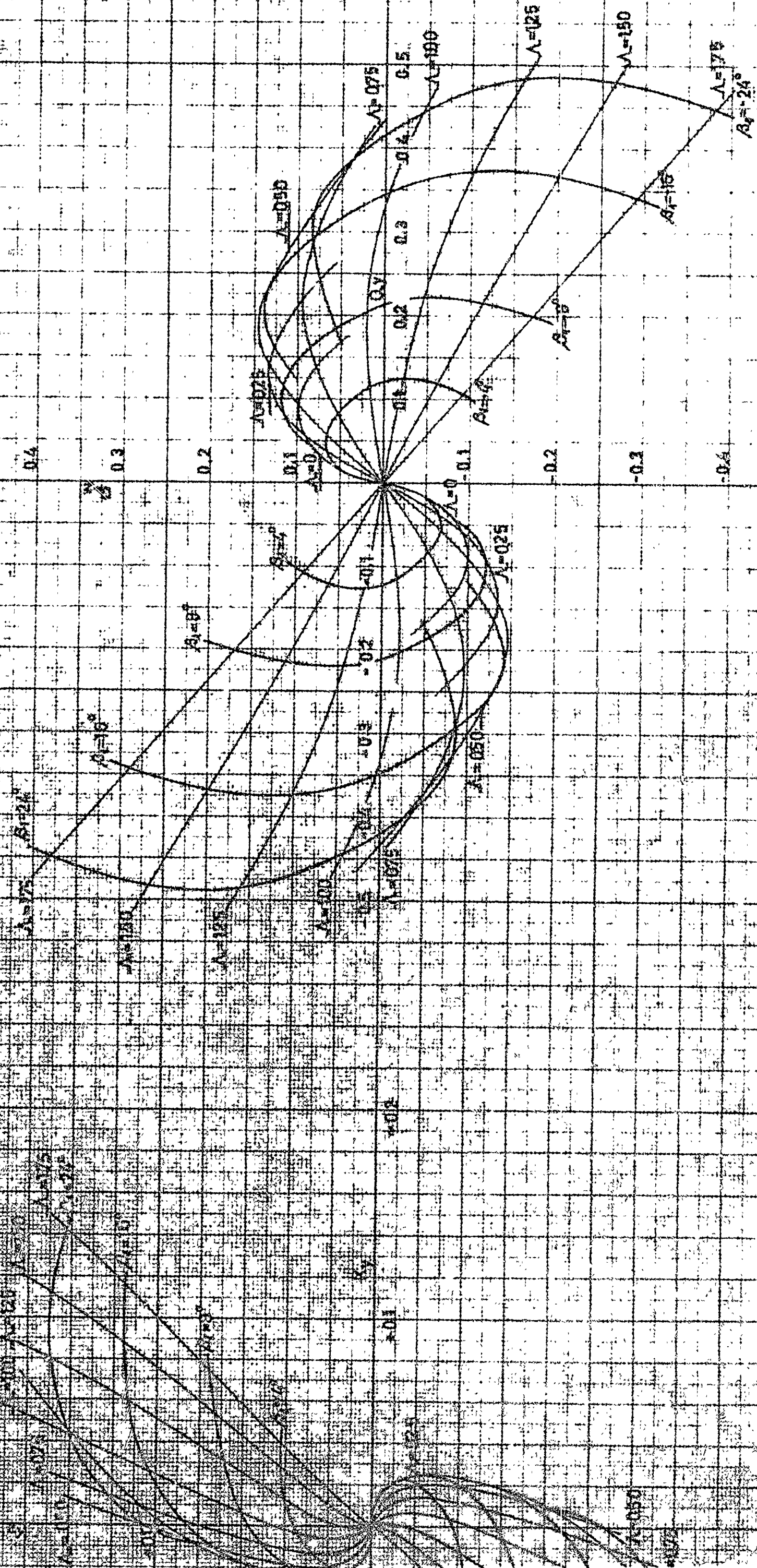
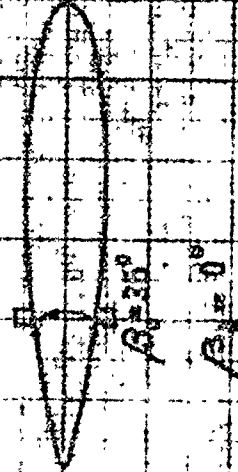
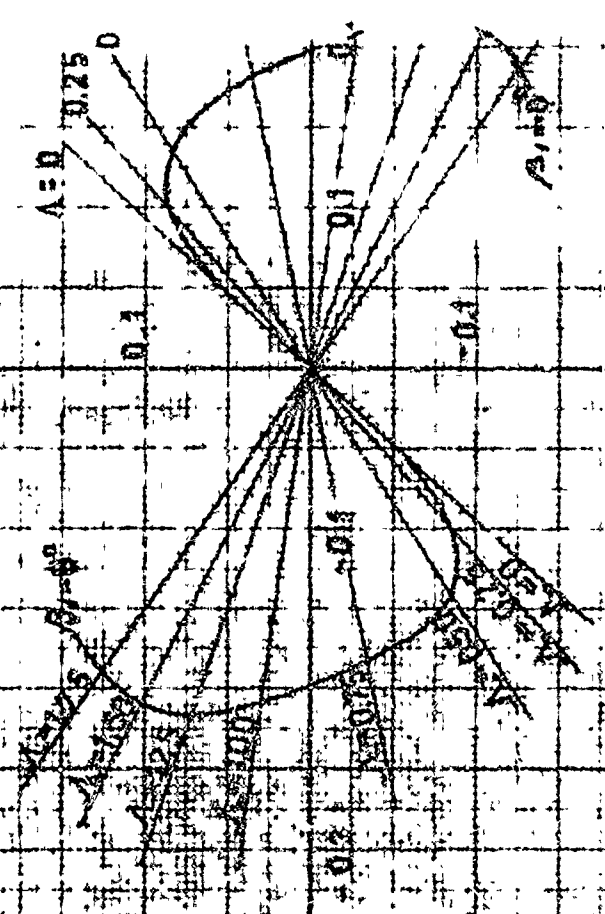
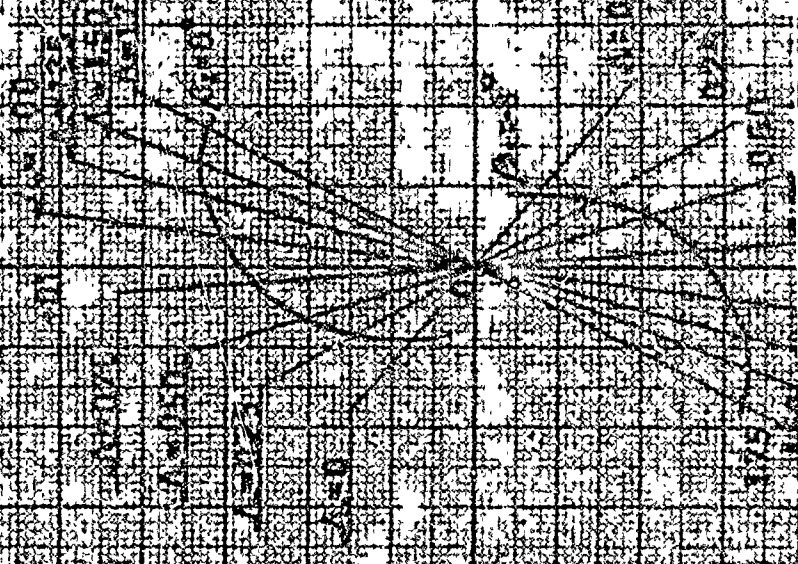


Fig 2.B3

A

S



8

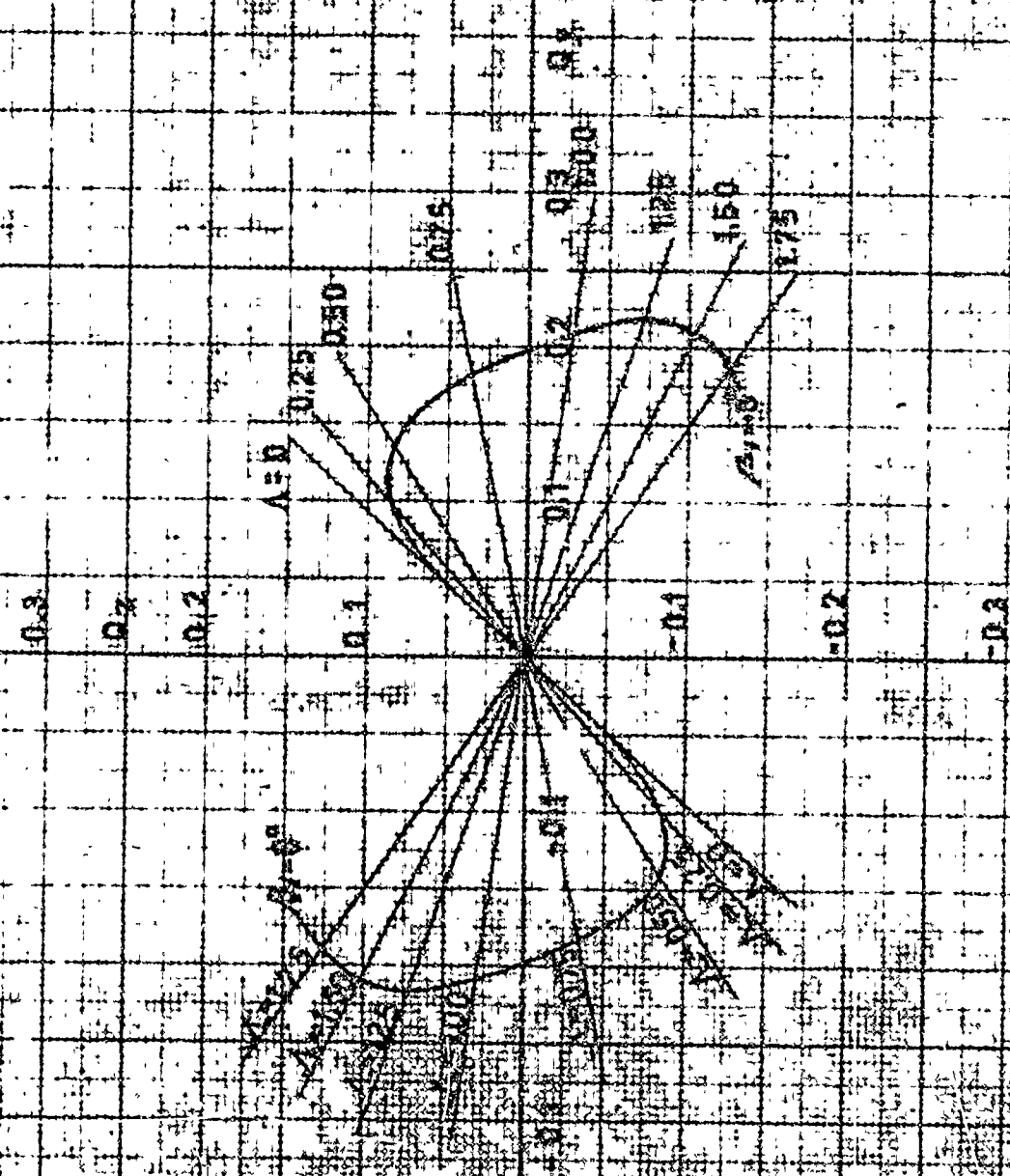


Fig 2.8.4